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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Event.

MAY-OCTOBER.

North-East Coast Exhibition at Newcastle-on-Tyne.

A Trade Union View.

Some interesting and important views were expressed in the recent annual report of the General Federation of Trade Unions, and particularly in the section dealing with the findings of the Management Committee. This committee began by pointing out that improvement in the standard of living must necessarily be preceded by increased production—productivity, as the economists would say—and that until such increase is effected it is useless to clamour for better food, better surroundings, or better social services for the community. Furthermore, it is clear that any reorganisation of industry upon more rational lines than those at present obtaining must contribute substantially towards this wholly desirable result.

This rationalising process, however, is clearly envisaged as being in essence no more than the latest manifestation of that perpetual flux and change within the industrial machine which is necessary to healthy progress. But if rationalisation is only the latest of a series of industrial developments, then clearly it must bring about many of the same problems as its predecessors, and may even in some cases intensify them. In particular the reorganisation of industry upon more rational lines cannot fail to involve the displacement of a considerable number of workers. This will be effected, according to the authority whom we are citing, in two ways—by the difficulty of finding a new job when a man or woman has been trained and practised in one rendered superfluous by the rationalising process, and by the ever-growing importance of the age and efficiency of the individual. We are assured that what the worker wants to know is whether the rationalisation of production will be accompanied by the rationalisation of distribution and life. Suggestions have apparently been made that some part of the profits accruing from the rationalising process should be devoted to the solution of this problem of the displaced worker, but unfortunately profits take some little time to accrue, and the worker is concerned for his prospects over the intervening period when he is likely to suffer most acutely from the changes.

Consequently suggestions are then made as to the study of this problem, and its possible solution is indicated along such lines as the development of individual adaptability, the education of the social sense, the extension of existing systems of unemployment insurances; or alternatively the creation of special displacement insurances.

The significance of this whole discussion lies, first, in the fact that it strips from "rationalisation" the rather fearful glamour with which the theorists are wont to invest it, and sets it in its place as no more than a fresh stage in the logical process of industrial growth; and second, in the recognition by the workers' representatives that the process is necessary and desirable provided the interests of the workers are safeguarded in the manner indicated above.

"Economy in Foundry Practice."

This is the slogan of the forthcoming Foundry Exhibition to be held in Düsseldorf from September 4 to 22. Those who had the good fortune to visit the one held some four years ago were impressed with the character of the display. Obviously, the more modern foundries are aware of the development in German foundry machinery, but they cannot, unless they personally visit Düsseldorf, acquire anything but a hazy notion of the immense amount of work which has been carried through to create the technical or educational section of the Exhibition. The leaders of the German foundrymen's organisations are pastmasters in the art of creating exhibits of a technical nature which drive home, in the most convincing manner, the need for modernisation of plant and the rationalisation of the industry. Elsewhere we detail the scope of the Exhibition, and in this connection it is interesting to note that Mr. J. G. Pearce, Director of the British Cast Iron Research Association, 24, St. Paul's Square, Birmingham, is arranging for a party of members to visit the Exhibition and some of the local works during the week-end September 11 to 16, and a limited number of non-members of the Association can be included if early application is made.

A Rival to the Cupola.

For the first time in the history of grey-iron foundry practice there has appeared upon the market a system of melting which claims to be cheaper than the cupola. The furnace in question is cylindrical and rotatory; it is fired by pulverised fuel. Roughly, the first claim made was that it melted at two-thirds the cost of the cupola. A later paper has reduced this figure to one-third. No installation has yet been made in Great Britain, but already a rival has appeared, which communicates a "jazz" movement to the furnace proper instead of a plain rotary action. The British rights of this latter furnace have been acquired by a very large foundry, and they propose to make an installation in the near future.

Foundrymen must realise in this connection that even if the costs of melting were the same, and providing decent working conditions for the bath be available, then because of the ability (*a*) to melt iron away from contact with the fuel, (*b*) to control much more easily chemical composition and casting temperature, the newer method would be worth while. There are still a few conditions which will always favour cupola melting. Primarily, through the medium of a range of ladles, shanks, etc., there is a certain very useful elasticity to be associated with the process, only capable of imitation by the

larger foundries which can instal a battery of rotary furnaces of varying capacities. Secondly, the wealth of tradition behind cupola practice renders its operation by purely "rule-of-thumb" conditions possible.

If the claims of these new furnaces can be substantiated, they will be welcomed by the industry as a long over-due improvement, yet we feel that the cupola, as an integral part of foundry practice, is by no means finished, for its rationalisation has only just commenced.

The Fifth German Foundry Exhibition.

The German Ironfounders Employers' Federation, after much scientific preliminary work had been carried out by a committee of leading men in the industry, with the co-operation of the German Foundry Technical Association, in consultations extending over many years, has decided to stage an exhibition of foundry specialities in Düsseldorf from September 4 to 29, after a lapse of four years in connection with their general meeting. The slogan of the Exhibition is to be "Economy in Foundry Practice."

As in 1925 the Exhibition will consist of an educational and industrial exhibition.

The Educational Exhibit.

This has been organised by the above-mentioned committee of leading men in the industry, the problem of reduction in costs in foundry practice is to be represented systematically by comparative displays of antiquated and modern methods in the under-mentioned sections:—

I.—*Works Organisation.*
- (1) Organisation in foundries.
- (2) Rationalisation of working.
- (3) Training of apprentices.

II.—*Foundry Layouts and Machinery.*
- (1) Development of the foundry from technical, historical and economical points of view.
- (2) Transport of machinery.
- (3) Power economy.
- (4) Salving waste materials.

III.—*Moulding.*
- (1) Pattern-making, including wood-working machinery.
- (2) Moulding materials.
- (3) Moulding practice.
- (4) Drying of moulds.
- (5) Fettling.

IV.—*Metallurgy of Iron.*
- (1) Raw materials.
- (2) Melting furnaces.
- (3) After-treatment (coating) of castings.
- (4) Annealing and tempering.

V.—*Metallurgy of Non-ferrous Metals.*
- (1) Raw materials.
- (2) Applied knowledge of metals.

VI.—*Materials of Construction.*
- (1) Testing of such materials.
- (2) Design of castings.
- (3) Cast iron in engineering practice.
- (4) Malleable castings.
- (5) Non-ferrous alloys.

The exhibits by firms will be grouped round the Educational Exhibit; the former will be displayed by exhibitors of all descriptions, by foundries, dealers in foundry requisites and appliances, in order to show to experts the many novelties introduced of late years in compact form. The number of firms who are to exhibit is greater than in 1925. Great stress has been laid on the fact that the firms, one and all, should adapt themselves to the guiding principle of the Exhibition, "Economy in Foundry Practice," in the same way as this has been done in all the sections of the Educational Exhibit.

Siamese Prince Visits Nottingham Foundry.

Several large contracts have been placed with Nottingham foundry firms, and Messrs. Cammell, Laird & Company, Limited, are at present working on the steel railway coaches ordered by the Siamese Government. Last week an interested visitor at the foundry, in King's Meadow Road, was Prince Purachatra of Kambeng Bejra, who carried a small cinematograph camera in order to record his visit to the works.

The Prince, who is the uncle of the King of Siam, is Minister of Communications for that country, and the principal object of his visit was to inspect the work that is being carried out for the Siamese Government. He was accompanied by Phya Prakit, B.Sc., Director-General of Posts and Telegraphs, and Chao Kavila, engineer on the Siamese State Railways and the third counsellor to the King of Siam. Accompanying the Prince and his suite were members of the Board of Directors of Messrs. Cammell, Laird, including Mr. T. L. Taylor, Mr. A. J. Boyd, Mr. W. Howard Williams, Mr. P. Wheeler, Commander Gand, Mr. C. F. A. Sandberg, Mr. H. Leatherborrow, Mr. A. E. Morgan and Mr. S. Brighouse, who were joined at the works by Col. Cockburn (general manager), Mr. A. N. Greenall (assistant general manager), Mr. S. J. Brooks (works manager), and Mr. C. Bingham (assistant works manager).

Before starting a tour of the works, the Prince inspected one of the steam coaches being built for the L.N.E.R., and travelled in it along the works track. Not only was he interested in the construction of the coach itself, and the coal consumption of power unit, but details also drew his attention, and he made several inquiries.

Subsequently the Royal visitor and his suite were entertained to lunch by the directors, and commented on the interesting and instructive visit. He stated that he was especially interested in the work in the foundry shops, and marvelled at the speed at which the men performed their work.

Association of Special Libraries and Information Bureaux.

Exhibition at the Annual Conference.

In connection with the Annual Conference, the Council has decided to hold an exhibition of apparatus, books, furniture, etc., likely to be of interest to research workers, information officers, librarians and others concerned with the recording, filing and dissemination of information. The sole purpose is to give to members an opportunity to examine devices—especially new devices—likely to be of use to them in their work.

The exhibition will be held in the Central Hall, Market Passage, and will open at 2 p.m. on Friday, September 20, and close at 1 p.m. on Monday, September 23. Exhibitors will have access to the hall during the morning before and the afternoon after. The hall will be open to the public on Friday, Saturday and Monday, and to members only for a short time on Sunday. In connection with this exhibition, it has been decided to arrange a members' section where members can exhibit any device, piece of apparatus, furniture, books or special system, forms, etc., which might interest other members and are perhaps of local or of foreign origin.

International Congress for Structural Steelwork.—This Congress is to be held in Liége in the course of the year 1930, under the patronage of the Belgian Government. A preliminary circular has been issued by the Executive Committee, 4, Place Saint-Lambert, Liége.

Random Shots.

As a pendant to my remarks on English as "she" is spoken in France, I have been recalling some instances of French as "she" is spoken in England. Once upon a time it was a sign of good breeding in this country to lard your conversation liberally with French phrases, as the chef lards his chicken with fat. Nowadays I believe—on the authority of the popular French novelists—that it is becoming a sign of good breeding for the French similarly to display their knowledge of English. French scholars will tell you, of course, that the language is far richer, and that there are occasions when the foreign word will convey a meaning far more accurately than the native one, but the argument seems to me a little specious. It might just as well apply to Chinese, I fancy.

* * *

French words in our English vocabulary are of two kinds nowadays. There are the words that we use with more or less conscious knowledge that they are French and with an attempt to pronounce them as such. And there are also the words that we have adopted and adapted, and that we use without a thought for their origin. "Chauffeur" is an example of the first class, but "garage" represents a transition stage, since it is not uncommonly called "gerridge." Still in the world of motors, we talk of a "coupé" with no attempt to anglicise the spelling. What could we make of it, then, I wonder? "Coopay," perhaps. The barber furnishes further examples—"coiffure," and "postiche" are considered a great improvement on "head-dress" and "wig," although no one knows why. "Rouge" is perhaps another border-line case, since it is spelt and pronounced á la française, but is certainly regarded as a native word. Then there are such words as "milieu," "confrère," "liaison," and their like—which I have seen before now in the columns of this journal, and which I may even have used myself on occasion. They seem so much more apt than "location," "colleague," and "link," though I am not at all sure that they are. The ladies, I believe, are fond of giving French names to the fabrics that they wear—"velours," "crêpe de chine," and "georgette" come to my mind, though I am not so bold as to promise that I would know them when I saw them.

* * *

The second class of words provide us with "bouquet," pronounced "bookay," with "buffet," pronounced "booffay," with "menu," pronounced "meanyou," and various others. One of the strangest to the ear is "lingerie," pronounced with a hard "g" and a "y" sound at the end. While I have even seen a perfectly serious newspaper correspondence over the derivation of the word "dishable," meaning a disordered state of dress, and apparently not by any means always recognised as a relative of the French "déshabillé."

* * *

And, while on the topic of foreign languages, I am reminded that even if you share Albert's views on the matter of going abroad for pleasure, you may still from time to time go abroad for business. Some of you, I fancy, may be going to Düsseldorf for the Institute of Metals meeting in September, and others to the Foundry Exhibition that will be held there during the same month. Shall I see you there, I wonder? Probably you, like myself, have not yet been able to complete your plans, although if you can recall the last occasion of the kind, as I can, you will certainly be in no two minds about the matter.

Marksman.

A Discussion on "Die Casting."

Mr. A. H. Mundey, in presenting his Paper,* took the opportunity, as an old friend and comrade, to congratulate Mr. Lambert upon having attained the position of President of the International Foundrymen's Congress and of the Institute of British Foundrymen, and also upon having been awarded the Oliver Stubbs Medal. It was a very great pleasure, he said, to find old friends and colleagues so honoured by those with whom they had worked, and who were best able to assess their value. Mr. Lambert had attained the respect of his colleagues in very full measure.

Special Steel Pots Used.

Mr. A. J. Shore, commenting on Mr. Mundey's reference to the solubility of aluminium in cast iron, asked whether, in view of that, cast-iron pots were not used for aluminium pressure die casting, or whether special cast-iron pots were used?

Mr. Mundey replied that for pressure die casting he used pots made of steel of a very special character, and not cast iron.

Relative Costs.

Mr. Henry Milner, discussing the pressure machine for die casting of aluminium bronze, said he had tried the use of aluminium bronze gravity-fed die castings for the making of all race cages, brush holders for electrical machinery, and products of that kind, and had found that sand castings coupled with facilities for cheap machining were cheaper than gravity-fed die castings. The "sand cast" job had not so good a skin nor was as true to size as the one which had been die cast, but the slow method of production of the latter outweighed these advantages.

He further added that where a job could be sand-cast with a number of patterns mounted on a plate, and the castings afterwards tooled on automatic chucking lathes, the final cost of production was lower than that of gravity-fed die casting.

A New Die-Casting Process.

Mr. Mundey said that at present there were no machines in this country for the making of die castings by the new process referred to in the Paper, but he was awaiting delivery of the first machine. Mr. Pechal and himself had inspected the new process in December, 1928, and had been negotiating ever since; the process had been modified just a little, and his Company had acquired the British Empire rights. It would be before the public in a very short time, and he regretted that he was not yet able to invite those attending the Congress to see the process.

Mechanical Properties of Die Castings.

Mr. W. Cartland referred to the efforts that had been made to improve the mechanical properties of die castings. At first, he said, die castings had a really large sale. The zinc-base alloy die castings produced under pressure had a beautiful finish, but their physical properties were not all that could be desired; they were brittle. Great improvements were effected in the zinc-base alloy die castings, so that they were less brittle, but from the point of view of mechanical properties they were nothing special. A long time had elapsed before the foundry had been able to produce pressure die castings in aluminium, applying the pressure by means of air instead of by plunger, and that represented a great advance; there was a great difference between the properties of the zinc-base and aluminium-base alloy die castings. To obtain castings with higher physical properties, however, it had been necessary to produce the aluminium-bronze or aluminium-brass gravity die castings, which had definitely good physical properties, but with gravity die casting one could not get the precision in finish that was desired. If one were able, by the new process, to produce, under pressure, die castings in alloys of the yellow aluminium-bronze type with high physical properties and first rate finish, it would appear that the foundry had made another great advance.

Another New Process.

The President said he had had the advantage of visiting Germany a few weeks ago, and had seen in operation there a plant for the manufacture of yellow metal die castings, the machine used being, to his mind, unique. A rectangular box, made of special steel, was suspended over the molten brass or yellow metal, the metal being contained in an ordinary plumbago pot. The rectangular box was lowered into the yellow metal and filled itself by gravity. The box was then lifted out by means of a lever arrangement and was swung over and clamped between two plates, one of which formed the orifice into the mould, the other being a blank plate. Air was applied to the rectangular box containing the molten metal, and by that means the metal was forced into the mould. He thought the apparatus was rather novel in its conception. He was given to understand that the contrivance was giving satisfaction, but he was told that there had not been a very great demand up to that time for pressure die castings in yellow metal as compared to the demand for gravity-poured yellow metal die castings.

Mr. Mundey said he had heard of the process described by the President. There had always been a temptation to adopt the vacuum method, by which the mould was exhausted and allowed to fill automatically. It was very difficult, however; the filling must be very good, and must be continuous.

The President suggested that Mr. Mundey might have emphasised a little more than he had done the necessity for constructing the die so that the air was allowed to escape from it. One of the great difficulties in die casting was to get rid of the air in the die, unless the die was properly constructed, but the difficulty had been overcome to a large extent. He mentioned this matter for the information of those who had broken up die castings, and were not enamoured of them because of the presence of one or two holes.

On the motion of the President, seconded by Mr. Sims, a hearty vote of thanks was accorded Mr. Mundey for his Paper.

* "Die Casting." See issues of June 27, page 486, and July 4, page 9.

National Federation of Iron and Steel Manufacturers.

New Organisation Formed.

A new company of particular interest to the iron and steel trades, to be known as the National Federation of Iron and Steel Manufacturers (Corporate Organisation), Limited, was registered on July 26 as a company limited by guarantee, without share capital, with 500 members each liable for one guinea in the event of winding up. The objects of the company are to promote the welfare of the iron and steel industry in the United Kingdom, and to co-operate in any manner that may be thought proper with, and generally to assist the operations of, the voluntary organisation known as the National Federation of Iron and Steel Manufacturers; to certify the origin, material, mode of manufacture, quality, accuracy, and other characteristics of iron and steel and goods manufactured therefrom; to apply for, register and own any trade marks to be used in connection with iron and steel, and iron and steel goods certified by the organisation, etc. The management is vested in an executive committee. The directors are:—Messrs. A. O. Peech, H. E. Parkes, E. J. Fox, B. Walmsley, J. Craig, J. Henderson and H. C. Bond, all members of the National Federation of Iron and Steel Manufacturers.

Catalogues Received.

Electric Motors.—We have received from Messrs. Higgs Motors, Witton, Birmingham, a four-page leaflet illustrating and outlining the characteristics of their single-phase repulsion induction motors. It is interesting to learn, from a covering letter, that good delivery can be given on this particular line—a rather refreshing statement after the number of complaints we have recently received from buyers of electric motors. These machines are constructed with a double-wound rotor, on the periphery of which is a winding analogous to a d.c. armature connected to a commutator in the usual manner. Below this there is a squirrel-cage winding. These machines are stated to develop twice full starting torque, with approximately three times full load current.

Foundry Melting Equipment.—The Universal System of Machine Moulding & Machinery Company, Limited, of 13-15, Wilson Street, London, E.C.2, has favoured us with an advance copy of their latest catalogue dealing with cupolas, cupolettes, spark arrestors, chimneys and ladles.

In the design shown for an ordinary cupola, the blast belt is placed above the tuyere level, a claim is made that this ensures an equalised distribution of the air. The design, incorporating a receiver is similar, the receiver being coke-fuel fired. These cupolas and the other plant detailed are made by the firm's principals, Messrs. Bonvillain et Ronceray, of Choisy de Roi, near Paris. It is interesting to note that $\frac{7}{16}$-in. plate is incorporated for the construction of the sheet. The well-known syphon-brick arrangement for the tap hole is described and illustrated.

Two pages are devoted to fans, which are of the well-known Rateau type. The arrestor described is of the simplest possible variety. It consists of a chimney carrying a chain suspended "mushroom," the chimney carries a series of internal angle irons for facilitating the lining, with ganister for protection.

The rest of the catalogue (five pages) is devoted to various types of ladles. There are ranges of crane-suspended hand-tilted, geared crane ladles, truck ladles, hand-tilting ladles mounted on wheels and bull ladles.

This catalogue has, obviously, been translated from the French, and in many cases it is far too literal to convey the full sense of the meaning. Moreover, several words have been introduced which are new to us, such as "pallet" and "brancard." We are not too sure what is meant by the former, it is probably an adjustable vane, but the latter is obviously a shank. The booklet contains sixteen pages and is well illustrated.

Furnaces.—The Wellman Smith Owen Corporation, Limited, of Victoria Station House, Victoria Street, London, S.W.1, have issued a 12-page well-illustrated brochure to outline the construction, operation and advantages of the Wellman-Chantraine multiflame furnace. It really represents a range of furnaces which have a double roof, the interspace between which form a reservoir for the hot combustion air. The lower section of this double roof is perforated by a quantity of small holes, through which the combustion air flows in downwards direction in the form of numerous jets. The fuel gas is arranged to flow immediately beneath the lower roof to form an intimate mixture. The waste gases leave the furnace at the hearth level, where they pass into a special type of recuperator and then into the chimney. This recuperator is composed of hollow square-sectioned tubes having enlarged ends. The waste gases flow through the pipes and air for combustion around them. The furnace is currently used for the heat treatment of cold-rolled steel strip, solid-drawn steel tubes, steel wire and rods, steel castings, steel sheets and plates, tinplates and for melting a number of non-ferrous. We congratulate the firm on the high standard reached in this typical example of their publicity matter.

XUM

Annual Meeting of the German Foundry Technical Association.

(*Continued from page* 86.)

Third Day.

On the morning of the following day the general meeting proper was held in the large meeting room of the German Society of Engineers, Berlin, which was filled to the very last seat.

The general meeting was opened by the President, Dr. Humperdinck. After a brief speech of welcome to the 400 foundrymen attending the meeting from Germany and other countries, including numerous representatives of the Government, official bodies, representatives of the city of Berlin, of the State Railways, Technical Colleges and Mining Schools, and members of kindred societies, the Chairman referred to the fact that the Society had now been in existence for 20 years. He then proceeded as follows:

Presidential Address.

The spirit of critical research and the unquenchable desire to arrive at the truth in the field of technical achievement, including the industrial side, still exists, and is even stronger than it was before; and this spirit has not been markedly changed by past or present struggles. We, as serious, thinking German foundrymen have always been convinced that we must as far as possible follow the lines of natural progress and systematic technical development in building up the science of engineering and industry and so advancing civilisation. If all Germans thought in this way, it would be all the better for Germany. Where there is life, there must always be its conflicts, contrasts and suspense; and these, which we meet with every day, especially in political life, come like lightning flashes to show us exactly where we stand. From one section abroad we are oppressed by heavy clouds pregnant with war memories, while from another section we are threatened by all sorts of measures and commitments that are of serious import to us. We Germans are too prone to ignore or abuse economic principles; are apt to overlook the value of the humble penny; yet, despite our crushing burden of debt, we are frittering away millions and millions of marks light-heartedly on objects that have no true economic value.

It is true that questions of a political and politico-economical character hardly come within the scope of our Society's activities; but, as both engineering and industry have been completely overshadowed by politics, I think I ought, in the interests of our actual work and further technical development, to make a few brief remarks on a subject that does, in its broadest sense, affect us.

We cannot ignore the fact that the historical development of Europe, and Germany in particular, has resulted in social and political ideas and considerations penetrating the field of industry, and that such ideas, etc., will penetrate still further. This penetration of politics into industry has not always taken place without a struggle. The further penetration, spread and repercussion of these ideas and theories will give rise to corresponding effects which will still further impair industrial operations. But we do know too that science, engineering and industry will prevail in the end by their inevitable laws. Now it is our duty, as it is the duty of all technical and industrial societies, to give emphasis to the legitimate aims and the positive character of engineering and industry, and to do everything possible to enforce them without entering too obtrusively into the conflict. We technical men of logical minds, being engaged in industry, must do our best to promote the real objects of industry, and at the same time do everything in our power to dispel the illusion that blinds industry—the false light that completely blinds men that are not sufficiently trained technically and industrially. For what, actually, is the effect of this illusion? By far the biggest percentage of the German people are under the illusion that our industry is in a much better position than it actually is. Ignoring possibilities, the vast majority of the public are being deluded by the fact that technical developments must eventually succeed in overcoming present and future difficulties. It is this kind of thinking that creates wrong and highly dangerous impressions as to our true position. The fact is overlooked that a time must come when technical progress and development will no longer be able to make up for the increasing burdens of all kinds that German industry will be called upon to bear, and which must necessarily result in increased prices, and so hamper output. Due to this illusion, endeavours are even being made, ostensibly for the welfare of the majority, to replace private industrial effort more than ever—*i.e.*, completely—by State socialism, these intentions being supported by the pretext that private manufacturing operations are purely selfish undertakings. But people who think thus refuse to believe that, if private enterprise ceases, engineering and industry will lose one of the most important factors contributing to its development and success.

But we German foundry engineers realise what is and what is not possible, and know full well that if further revolutionary ideas of this kind gain ground, it will mean that our country must become a land devoid of self-determination and room for expansion, a country without work and without food. Exactly when this state will arrive it is impossible to say definitely, but come it must, unless the pendulum of thought swings in the other direction and removes these perverted ideas about industry.

As regards the problem confronting us in particular, it is simply this: that we, as German foundrymen, must do everything we can to further develop German foundry engineering as a whole, and so promote German industry to a gradually increasing extent.

Annual Report.

The Secretary of the Society, F. Bock, Foundry Engineer of Berlin, then read the following report on the work of the Society:—

The Report shows that the membership of the Society increased notably during the year, and that, compared with the previous year, unemployment among foundry engineers had decreased slightly. Nevertheless, the number of technical foundrymen out of work or without posts is considerable. The joint journal "Die Giesserei" has successfully progressed during the past year, and the Society's efforts at uniformity in literary matters have given practical results.

All sections of the Society were very active during the year, and cohesion amongst the members was considerably promoted and strengthened.

At the invitation of the Austrian Section the Society held the first German Foundry Conference in Vienna from September 22 to 24, 1928, and this provided an opportunity for the numerous members from Germany to confer and collaborate with the Austrian members and professional colleagues. In connection with this conference the members made an educational trip to Hungary, where they met with a splendid reception both from State and Municipal authorities and the Hungarian industry. This trip served to strengthen the bonds of friendship that have always existed between Germany and Hungary, and to extend these bonds to the foundry industry.

Most of the Society's work was done by the special committees, which were actively engaged throughout the year. Of the work already completed, the results have been published partly in the Society's journal, while some have been published separately and others are being prepared for the Press.

The following are some of the problems with which the committee have dealt: work on moulding sands, by the Moulding Sands Committee, which has tested various German moulding sands by the Reitmeister method with a view to characterising their physical properties.

The work done by the Electric Furnace Committee with regard to the Dimensions and Outputs of Electric Arc Furnaces has now been finished, and the results have recently been published separately in the form of a detailed report by Dr. Kothny. A survey of the whole of the literature published in Germany and abroad on electric furnaces is being prepared for the Press.

Extensive investigations on the subject of high-quality cast iron are now occupying another committee, while the Metal Foundry Committee have concluded a number of investigations, including one on what are termed commercial cast brasses, and another research entitled "Contribution to the Knowledge of the Hardness Properties of Standard Cast Tin-Bronzes, Gunmetal Alloys, and Lead-Tin-Bronzes."

The question of investigating the reaction of foreign metals on the strength properties of cast aluminium alloys is at present occupying the Committee, which is, however, now mainly engaged in the preparations for the Fifth German Foundry Exhibition to be held at Düsseldorf in September, 1929.

The question of the proper training of Foundry Engineers at the Technical and Mining Colleges has recently formed the subject of negotiations and discussions with the High School Committee of the Society. In agreement with the *Verein deutscher Eisenhüttenleute* (German "Iron and Steel Institute") and the other Foundry Associations, it was agreed to allow the work of the High School Committee of the *Verein deutscher Eisenhüttenleute* to take its natural course so as to ensure all the requirements of the industry being uniformly represented. It is agreed in principle in professional circles that the training should be given from the metallurgical rather than from the mechanical engineering side. Reports on the work of the Foundry Standards Committee regularly appear in the journal "Die Giesserei."

The negotiations that have recently taken place between producers and consumers of foundry melting coke with regard to the quality, etc., of the coke have led to the formation of a Coke Committee. It is proposed to carry out experiments in a number of foundries—an arrangement that will enable the tests to be made simultaneously with a number of cupolas.

The Society has entrusted to the Technical Foundry Committee the experiments dealing with "the improvement of cast iron by refining elements."

The Apprentice Moulders' Committee is now engaged on its main task of carrying out propaganda work to attract youths to this trade. This it is doing by the publication of propaganda articles in the daily papers, by circulars to the heads of schools, and by the preparation of propaganda literature. As a result of the Committee's work, the number of apprentice moulders entering the industry in 1928 has increased.

With a view to cheapening industrial production in the iron, steel, malleable iron and non-ferrous metals industries, the Society are now forming a "Joint Committee or Consortium for Foundry Practice." The aim of this committee

will be to see that all suggestions and experience are exploited industrially, and to promote economy in production by organising lectures and courses of training on industrial management.

The following members were re-elected to the Council: Dr. Wirtz (foundry manager), Dr. Krieger, Prof. Paschke, Dr. Pardun.

After the business part of the agenda had been disposed of, Dr. Piwowarsky read a paper, of which the following is a summary:—

Comparison of the Metallurgical Value of the Basic and the Acid Steel Processes.

By Dr. Piwowarsky.

Starting from the concept of quality, the author develops the casual connections between the usual methods of working adopted in acid and basic open-hearth furnaces, and the physico-chemical reactions underlying them. His considerations are based on modern ideas of the constitution of basic and acid furnace slags. He regards the basic open-hearth furnace slag as a highly dissociated melt-solution of silicates of lime and silico-phosphates, which form the solvent for the oxides in the "free" state. By considering this solution in terms of the law of mass-action, Nernst's theory of distribution, and other fundamental laws of physical chemistry, important deductions can be made as to the metallurgical value of the basic steel process, in regard to dephosphorisation, deoxidation and desulphurisation. In contrast to the basic slags, the acid open-hearth slags, in the form of melt-solutions of olivines and pyroxes, are only slightly dissociated. From this, important deductions are possible with regard to the deoxidising value of acid open-hearth furnaces. The author also dealt with the real significance of the concept of "basicity," the unique position of magnesia and silica in highly basic slags, the difficulties of taking samples, and the unavoidable sources of error in slag analyses. He also outlined the conditions which conduce to the steel cooling without blow holes forming, and pointed out the differences—the cause of which is still not clear—in the solidification, cooling and further use and treatment of the two types of steel dealt with.

The *Training of Foundrymen* was dealt with in two papers.

The Training of Technical Foundrymen at the Technical and Mining Colleges.

By Dr. Paschke, of Clausthal.

In dealing with this important question the writer refers first of all to the fact that our whole aim should be to produce quality work, with special emphasis on the point of economy or cheapness. The final aim is crystallised in the words of Dr. Humperdinck: "The man of knowledge (the scientific man) is king in industrial life." Dr. Paschke took the three factors of applied science, actual practice, and sensible organisation as combining to produce economy of production, and compared them with an ascending straight line, which naturally diverges from the horizontal line which accompanies it. This horizontal line represents the line of contemplative or meditative existence, or the line representing contemplation of and contentment with what has already been achieved. He then goes on to show how science with its wonderful array of facts and rich treasure of discoveries and inventions has a favourable effect on the outlook of the college-trained foundry engineer. In order, however, to do full justice to practical requirements, we must try to find out what is the best equipment for the college-trained man for his calling. With a view to elucidating these questions, the writer explained in detail the endeavours of the High School (Technical College) Committee, composed of the appropriate professors of the Technical and Mining Colleges and leading foundry experts, working under the ægis of the *Verein deutscher Eisenhüttenleute* (German "Iron and Steel Institute"). This Committee are unanimously of opinion that the main training of the foundry engineer should be on the metallurgical rather than on the mechanical engineering side, after the student has been trained (prior to his preliminary examination) in chemistry and physical chemistry as a basis for metallurgy, and mathematics, physics and technical mechanics as a basis for mechanical engineering as applied to metallurgical and foundry work. The author points out that laudable aim of increasing quality in production can only be achieved when the *Diplom-Ingenieur* (Engineer by Diploma) is thoroughly familiar with the internal constitution of matter. Just think of the question of the quality of pig-iron, of the complicated melting processes, the question of shrinkage, segregation and piping and their reaction on the distribution of stresses, of the question of corrosion, wear, density and heat-treatment, which can only be solved with a knowledge of metallurgy and metals. But considerable attention must also be paid to the technology of casting, the chemical and physical examination of moulding substances, etc. Similarly, the question of malleable iron, of roll cast iron, and other special types can only be solved with the help of metallurgy and metallography. Dr. Paschke also stresses the importance of economic production, insisting that proper consideration should be given to mechanical engineering, and in particular, the question of proper design, as such knowledge, combined with a knowledge of metallurgy and metallography, is frequently necessary to discover the causes of rejects and wasters. The question of the machining and transport of castings, etc., should also be dealt with as their importance merits. In principle, then, the student should be able to deal with metallurgical-metallographical and mechanical engineering and design problems, and at the same time his training should fit him to handle actual problems in foundry practice. Equally important, in the writer's view, are questions of economic and industrial organisation, the principles of salesmanship, the elements of economic statistics and industrial law, estimating and time-studies—all of which come under the general term of scientific management. A proper study of the whole—metallurgy, mechanical engineering and works management—forms such a happy combination that a *Diplom-Ingenieur* who has obtained his diploma principally for metallurgy is also (qualified to be) a works manager. Lectures and courses of study should, then, be organised on these lines. Educational experience in the Technical Colleges has, however, shown that the knowledge acquired from lectures must be made tangible, and, therefore, more profound, by practical work, and consequently these practical exercises must constitute an important part of the course of study. The writer advocates a course of training properly dovetailed in all its details which, as previously, will enable the student to carry out twelve months' practical work, and also allow him to sit for his examination at the end of the fourth term (of six months) and to complete his studies at the end of the eighth term (of six months). The problem set him for his diploma should then, if possible, be worked out by him while he is working at his profession, and the College authorities should make sure whether the student is equipped with the requisite theoretical and practical knowledge and knows how to apply it. Part of the work for the diploma can, however, be done in the institutes of the Technical and Mining Colleges. The same remark applies to the thesis for the doctorate. After the thesis for the diploma has been set, the student should undergo his oral examination.

If an "Engineer by Diploma," trained on these lines, takes up a post in a foundry, there is every assurance that he will not only have the requisite knowledge, but will know how to apply it. A certain amount of the spirit of and the desire for research must, however, also be inculcated in him, so that his faculties are not blunted with the routine of his daily work, and that the manifestations of the natural forces do not escape him in his calling. Instruction in foundry practice must, therefore, be arranged so that it shows the practical application of the theoretical principles and gives the student a deeper appreciation of the meaning of his work. This knowledge is extremely important, as it gives the Diplom-Ingenieur self-confidence at the outset, coupled with a love of his work and the pleasure of self-expression, for technical progress is impeded without an interchange of ideas and experience. Dr. Paschke refers in this connection to the need for inspired work on the practical side and its favourable effect on the tempo and efficiency of technical progress, and closes his clearly outlined statements with the words of Dr. Albert Vögler: "Science establishes principles and seeks after the causes of things; while technology takes the knowledge thus acquired and moulds and builds it up. Industry completes the process; it connotes the systematic exploitation or utilisation of technology. Without science there can be no fresh creation, no developing and no perfecting."

The Training of Foundrymen at the Technical Secondary Schools.

By Dr. Geiger, Esslingen.

At the present time there is only one Technical Secondary School in Germany where definite instruction and training are given for foundrymen, viz., the State Mechanical Engineering and Metallurgical School at Duisburg. This school is capable of turning out 30 to 40 technically trained foundrymen per annum of average standing, *i.e.*, scarcely half the present demand. The majority of foundry technicians and works engineers who are not college-trained are obliged to attend Mechanical Engineering Schools or institutions of similar status for their theoretical training, and here they receive the same instruction as machine designers.

The number of hours devoted to the teaching of foundry practice in the Lower and Higher Grade Schools of Mechanical Engineering has been cut down to practically half in the last eighteen months, and now averages about 40 hours altogether. This point has an important bearing on the knowledge to be imparted to the future designer, especially as an appreciable percentage of the scholars or students have had no practical training in the foundry or the pattern shop, and have no knowledge of even the most elementary processes in the foundry. Another difficulty facing the schools is that of finding men sufficiently trained in foundry work to act as teachers. The author maintained that, as far, at any rate, as concerns the Schools of Mechanical Engineering which train independent designers, it should be a condition of admission that students should have had at least 3 months' practical foundry experience, and he emphasised the fact that such a condition was quite feasible.

As regards future technical foundrymen, training at Schools of Mechanical Engineering cannot be regarded as sufficient, because nowadays the foundrymen is expected to have wider metallurgical knowledge than designers have. It is extremely difficult to re-train men by supplementary or continuation courses, because such courses usually only give certain specialised instruction in a brief period, but the students are not taught to think in terms of metallurgy. The writer suggested that this defect could be obviated by linking up metallurgical departments in the Higher Schools of Mechanical Engineering in districts which were specially important as regards the foundry industry, these departments being opened, as required, every 2 to 3 years, for the reception of scholars.

The final paper of the meeting was read by Prof. Dr. F. Dessauer, of Frankfurt, under the title of "Engineering and Industry."

In terms of philosophy he outlined the im-

(*Continued on page* 96.)

Oxidation Losses in the Cupola.*

CALCULATION OF THE IRON LOSS BY OXIDATION FROM THE SLAG.

By Emil Knoppick.

Recent progress in cupola construction expresses itself in the main, in a lower coke consumption and shorter melting period—this, by better utilisation of the heat energy of the coke, in other words, the more efficient combustion of the carbon to form CO_2. As, however, from the equation $Fe + CO_2 = FeO + CO$, it must be assumed that, in the highly oxidising atmosphere, a greater melting loss results, a portion of the saving on coke thus being lost again on pig-iron, it has been necessary to place in the foreground the question of the iron loss by oxidation.

Although it has become very important, therefore, for the foundryman to learn the real melting loss in the cupola, the way in which this has hitherto been determined is not, in the author's opinion, always satisfactory. Usually, the calculation is merely based on the iron content of the slag, but this can lead to quite false conclusions, as the slag contains iron oxides derived from *all* the constituents of the charge (iron, coke and limestone), as also from the furnace lining. Moreover, the greater the quantity of slag formed from substances other than iron, the lower will be the concentration, in the total slag, of the actual iron oxides. Hence, less iron and manganese will be found than if the total amount of slag had been smaller, although the percentage iron loss may be the same.

The coke employed in Germany for the melting of iron in the cupola furnace gives, on an average, 9 per cent. of ash and contains 1.2 per cent. iron and 1 per cent. sulphur. The addition of limestone, up to one-third of which can be replaced by fluor spar, serves to slag the ash from the coke and to combine with the sulphur, as also the sand adhering to the pig and the foundry scrap charged into the cupola. Theoretically, a coke, for example, having 9 per cent. ash, 1 per cent. sulphur and 5 per cent. water requires 16 per cent. of calcium carbonate. If the limestone contains, as impurities, silica, alumina and iron (Fe about 0.25 per cent.) a definite part of its lime content must be expended in slagging these constituents also. If 5 per cent. of impurities are present, for example, a further 2 per cent. of limestone is necessary.

The sand adhering to the iron of the charge can be taken to average 0.5 per cent. of the weight of the iron: it requires about 1 kg. of limestone. If the furnace melts with 10 per cent. of coke, a total of $10 \times 0.18 + 1 = 2.8$ kgs. of limestone would have to be added to an iron charge of 100 kgs. In general, the addition of limestone to the extent of 30 per cent. of the weight of the coke is reckoned upon, in order, also, to neutralise the silica from the fused cupola lining. Of the sulphur from the coke, experience has shown that approximately one-half is fixed by the lime. Thus, per 100 kgs. iron, $3 \times 0.57 + 0.95 = 2.66$ kgs. of slag-forming material must be charged into the furnace, which contain a total of 0.126 kg. iron. (The analysis of the limestone is here taken to be 57 per cent. non-volatile matter, of which 0.2 per cent. is Fe; the coke contains 9 per cent. ash, 1.2 per cent. Fe and 1. per cent. S, of which latter, however, only one-half enters into the slag; the coke charge is 10 per cent. of the weight of the iron.)

The quality of the cupola lining greatly influences the quantity of slag. The refractory bricks and cement also contain about 1.2 per cent. of iron which increases the quantity found in the slag, thus contributing their share to a false picture of the iron oxidation losses. It has been repeatedly demonstrated that with poor-quality refractory bricks more than half the slag comes from this source.

If two slag analyses are considered, one showing, say, 10 per cent., the other 20 per cent. FeO, it will not be possible to say straight away that the second, with the higher content of ferrous oxide, really proves a greater oxidation loss than the first slag with only half the content. In order to decide the question, certain calculations must be performed. The first essential in this connection, next to the obtaining of a truly average sample of slag, is the determination of the weight of the whole of the slag formed. Two practical examples will show how the calculation is made.

Example 1.

Total weight of iron charge	36,500 kgs.
,, ,, ,, coke (5 per cent. H_2O) ..	3,287 ,,
,, ,, ,, limestone	1,265 ,,
,, ,, ,, slag	3,850 ,,

The analysis of the slag gave: 7.26 per cent. Fe = 9.34 per cent. FeO and 2.52 per cent. Mn = 3.25 per cent. MnO.

The oxidation of the silicon, experience has shown, amounts to 10 per cent. of the calculated silicon content of the iron mixture employed. If the latter was 1.75 per cent. Si, a total of $36,500 \times 0.0175 = 638$ kgs. Si were charged into the cupola, of which 10 per cent. or 64 kgs. oxidised, forming 136 kgs. SiO_2, contained in the slag.

As the oxidation products from a charge of pig and foundry scrap consist mainly of the oxides of Fe, Mn and Si, there are present in the slag:

$3,850 \times 0.0726 =$	280 kgs. Fe or	360 kgs. FeO
$3,850 \times 0.0252 =$	97 kgs. Mn or	125 kgs. MnO
	64 kgs. Si or	136 kgs. SiO_2
Total	441 kgs.	621 kgs.

This total includes the iron originating from the slagging of the coke ash, the limestone and cupola lining. This iron can be deducted as follows:—

Slag formed apart from fusing of cupola lining, i.e., *from*:—

Coke (9 per cent. ash + 1 per cent. S)	$3,287 \times 0.095 = 314$ kgs.
Limestone	$1,265 \times 0.57 = 722$,,
Sand from pig, rust, etc. ..	$36,500 \times 0.005 = 183$,,
Iron, etc. oxidation products, as above	621 ,,
Total	1,840 kgs.

As now, the total weight of slag is 3,850 kgs., 3,850 – 1,840 = 2,010 kgs. are formed by the fusing of the furnace lining, giving an iron addition of about 24 kgs. In all, approximately 70 kgs. of iron ($3,287 \times 0.012 + 1,265 \times 0.002 + 2,010 \times 0.012$) were imparted to the slag from the coke ash, the limestone and cupola lining, so that, of the 441 kgs., only 371 kgs. remain which can be regarded as the net oxidation loss in the cupola. Expressed as a percentage of the iron charge this gives a melting loss of 1.02.

Let us now take, as a second example, a case where the slag has double the iron and manganese content but there is only half the quantity of slag, the iron charge being the same. This may occur, when, owing to low coke consumption, less limestone is necessary and the melting time is shorter, or the cupola lining offers a better resistance to the attack of the slag. Applying now a calculation similar to that above, there is found, not double the iron loss, but almost the same as in the first case. This is made clear by the following:—

Fe 14.5 per cent. = 18.6 per cent. FeO
Mn 5.5 per cent. = 7.1 per cent. MnO

Iron charge	36,500 kgs.	
Coke (7 per cent. H_2O) ..	2,555 ,,	
Limestone	780 ,,	
Total slag	1,925 ,,	
$1,925 \times 0.145 =$	278 kgs. Fe or	357 kgs. FeO
$1,925 \times 0.055 =$	105 kgs. Mn or	136 kgs. MnO
as above	64 kgs. Si or	136 kgs. SiO_2
Total	447 kgs.	629 kgs.

Slag formed apart from fusing of cupola lining, i.e., *from*:—

Coke (as above)	$2,555 \times 0.095 = 242$ kgs.
Limestone	$780 \times 0.57 = 445$,,
Sand, etc.	$36,500 \times 0.005 = 183$,,
Iron, etc., oxidation products, as above	629 ,,
Total	1,499 kgs.

Cupola lining therefore 1,925 – 1,499 = 426 kgs.

The iron content from coke ash, limestone and furnace lining is, according to the previous mode of calculation, about 45 kgs., which must be deducted from the above 278 kgs., so that the resulting oxidation loss is only 402 kgs. or 1.1 per cent. of the iron charge—scarcely a tenth more than in the case of the first slag having half the iron and manganese content, which, generally speaking, can be looked upon as the normal.

If it is further borne in mind that in both cases a not inconsiderable quantity of rust passes into the slag, the amount of which cannot be determined in figures, it may confidently be concluded that the real melting loss by oxidation in the cupola is very small. When, in spite of this, foundries reckon upon a considerable loss, this is rather a sign that much iron is being lost through spilling.

* Slightly condensed from "Die Giesserei."

Annual Meeting of the German Foundry Technical Association.

(*Continued from page* 95.)

portance of engineering science (or technology) for the intellectual ascent of mankind in their struggle to subdue and harness the forces of nature. He investigated thoroughly the essential difference in the two concepts—engineering and industry. "Industry," understood in its broadest sense, is a social process in which there must always be several actors: five human actors, viz., the industrialist as representing the talent, the capitalist, the collaborator, the consumer and the regulative members; and two objective factors: Nature and Technology (or Engineering). The real object of Industry is to take each of these factors, and, without disturbing them, to co-ordinate and develop them in this sevenfold corporation. Engineering is also a social process, although it can be developed by the individual man. The true purpose of engineering is to take ideas from the sphere of the immaterial and translate them into material terms. Whatever form Industry may assume, Engineering will remain the same in substance. Industry and Engineering are united in all civilised nations. Industry develops Engineering, and *vice versa*. It is not, however, correct to maintain that Industry is the big factor and Engineering only the instrument. According to mental and spiritual laws, Engineering or Technology comes first, and Industry proceeds from it.

Prof. Dessauer's observations, as also the other papers, were received with keen approval by those present.

The general meeting of the German Foundry Technical Association concluded with a vote of thanks by the President to those taking part, followed by a dinner in the "Kaiser" salon of the Rheingold Restaurant.

XUM

International Views of Alloy Additions in Cast Iron.

Three Papers, presented to the International Foundry Congress, "The Influence of Chromium in Cast Iron," by J. W. Donaldson; "The Influence of Manganese in Cast Iron," by A. L. Norbury; and "The Practical Application of Nickel in Cast Iron," by A. B. Everest, formed an excellent basis for a discussion on the potentialities of alloy additions to cast iron for its economic amelioration. It was opened by Mr. H. Field who, speaking with regard to the machinability of nickel cast iron, said Dr. Everest had only put forward data of an iron of one particular composition. The use of nickel seemed to be limited in application to a very small range of silicon irons, but it seemed that if the silicon was slightly reduced and some nickel added a more machinable iron was obtained. Could the author say what was the result of adding nickel to the higher silicon irons? Personally he was interested in cast iron with a Brinell hardness in a ¼-in. section of 70 to 75 and was there any possibility of nickel helping to obtain a result of that kind? There was no reference in the Paper to the application of nickel to the higher silicon irons, nor was the application of nickel to metal used for electrical purposes mentioned. He had in mind electrical-resistance grids and similar work. The Paper suggested a particular range of silicon as being more favourable to the addition of nickel in order to obtain the best results. In the case of electrical-resistance grids 3 to 3½ per cent. of silicon was used, and if nickel were added to obtain a better resistance, could the silicon be reduced to 1.8 per cent.?

Manganese and Shrinkage.

With regard to manganese, Dr. Norbury in his Paper dealt with the shrinkage in grey cast iron, and it would be useful to hear something with regard to the shrinkage which gives trouble in the foundry, viz., draw holes and shrinkages. A certain amount of work had been done by Cook and others, but in general foundry practice had progressed little in the past 20 years in the control of draws and shrinkages, by way of the analysis of the iron used, and that was undoubtedly one of the greatest difficulties with which the general ironfounder, making a large range of work, had to deal. Therefore, he would like to know whether Dr. Norbury in referring to shrinkage intended to make any suggestion with regard to draws and shrinkages. He did not know whether he was in order in making any comparison between Northamptonshire and Derbyshire iron, but he believed it was generally recognised that Derbyshire iron gives less trouble with draws and shrinkage than Northamptonshire iron. He had proved that time after time in separate experimental heats numbering many hundreds, and had come to the conclusion that the manganese in the Derbyshire iron—which was greater than in the Northamptonshire iron—has much to do with the immunity of the Derbyshire iron from shrinkage. He might be totally wrong, but it served his purpose to work in that direction; at the same time, he would like Dr. Norbury, if possible, to enlighten him on the subject.

Lowered Phosphorus Reduces Shrinkage.

Mr. R. S. Macpherran (American Foundrymen's Association) remarked that experience in the United States entirely confirmed what was stated in Dr. Everest's Paper with regard to nickel, from ½ to 1 per cent. nickel was used in castings for cylinder liners, crankheads, etc., and in that way castings had been obtained which otherwise would not have been machinable. By adding 1 per cent. nickel something like 0.5 per cent. silicon was eliminated and a machinable casting was obtained. Had Dr. Everest made any definite tests for wear of such material on any standard wear-testing machine? So far there had not yet been developed in the States a satisfactory machine for testing wear in cylinders or frictional wear generally. As regards the point mentioned by the last speaker, viz., shrinkage, this had been reduced in the States by using a lower phosphorus content. In that way the good castings had been increased, keeping the phosphorus below 0.2 per cent.

Overcoming Gear-Blank Porosity.

Mr. J. Longden pointed out that although it was said that the addition of nickel results in the absence of porosity in castings, the findings given in the Paper related to sections which were really on the small side. In the case of a relatively small gear blank, 16 in. diameter as cast, with a rim face 2½ in. wide and 2¼ in. deep, and on which the faces had been machined and teeth cut 1½ in. deep, nothing could be hidden after the machinist had done his work, all the faults of the metal being laid bare to the world. At present these castings had the following composition:—Silicon, 1.3; manganese, 0.8; total carbon, 3.2 to 3.3; phosphorus, 0.4, and sulphur, under 0.1 per cent. From the Paper it seemed to him that if there were porosity trouble it would be necessary to lower the silicon a certain amount, add a definite quantity of nickel, and hope for better results. At present, in order to render the castings referred to sound, it was necessary either to chill or to feed, and he would like to know if Dr. Everest could say whether it is possible to obtain such a casting sound by the aid of nickel without either feeding or chilling. He did not think it could be claimed as a general proposition that the reduction of silicon to any extent was necessarily a step in the direction of increasing solidity. There must be a certain minimum line beyond which there was no reduction of cavity consequent on the lowering of silicon content. By reducing the silicon to the minimum possible or practicable, one could get a casting which would stand up to a pressure test; but it did not follow that the casting was free from cavities. He came across a case recently in which there was a spongy mass of material, leaving ⅞ in. sound metal between a steam chest and the outer world which had held up for 30 years. Therefore it did not follow that with a pressure-tested casting there were no internal cavities, and all troubles were over. He was wondering whether in the case of a gear-blank such as he had mentioned the reduction of the silicon from 1.3 to 1.2 or 1.1 and the addition of a certain percentage of nickel would reduce the porosity, and if so, why? As a matter of fact he had recently cast one of these blanks without reducing the silicon but adding about 2 per cent. nickel, and was sorry to say that porosity showed itself in the rim. This was without, of course, any additional work by way of feeding or chilling. He had also tried a crystallisation shrinkage test on the same iron, and again the conclusion was that an iron of the character he had outlined containing about 2 per cent. nickel, cast in a green-sand mould, lost about 3 per cent. of its volume on freezing. This loss would have to be made good by one or other of the various methods known to the foundryman. Consequently, the value of nickel additions in such cases was very doubtful.

Nickel Additions and Internal Porosity.

Mr. R. F. Harrington (American Foundrymen's Association) said he was a firm believer in the use of nickel for the purpose of removing internal shrinkage, and he believed nickel had its definite application as suggested in the Paper by Dr. Everest in that it prevented waste castings by providing a more uniform structure. Indeed, he did not think that the use of the cast test-bar fully revealed the real value of the addition of nickel to a casting, and when a casting was broken up the evidence of the advantage of adding nickel was much more definitely shown. At the same time he did not think the elimination of internal porosity would come about by the use of nickel, and there were many investigators who held similar views.

Manganese Content and Chill.

Mr. John Shaw, speaking first in regard to Dr. Norbury's Paper, said he was pleased that the author had furnished further evidence that manganese up to at least 0.3 per cent. above that required to satisfy the sulphur present reduced the combined carbon. It was thought by some that he might have found a higher figure if he had not used synthetic materials, especially if tried on a thick section. Some twelve months ago Dr. Norbury had promised to try this latter out by casting two 3-in. bars in moulds heated to a high temperature, one containing a low manganese content, the second with about 0.6 per cent. above that required to form MnS. Could the author say if he had found time to test this out, because it was of some importance to those making very thick hydraulic cylinders. The hardening effect of manganese was not very apparent in Fig. 1. Coe's C.C. rose from 0.19 per cent. with 0.37 per cent. Mn to 0.51 with 2.09 per cent. Hamasuma's had 0.74 per cent. with 0.38 per cent. Mn and 0.87 per cent. C.C. when the Mn was 1.19 per cent., with little sulphur in either case. Wüst's figures in D and E were very similar. Although the Brinell numbers might increase, due to alteration of structure, and graphite, machining was not effected up to 1 per cent. Mn. Cook had frequently stated that he found anything above 0.4 per cent. manganese had a tendency to chill in cylinder work. This was due to the denseners he used in his body core, and the speaker thought he noticed in Fig. 15 some work he did years ago. Below were two other chill tests, 15 C and D. He would like to know how these figures were obtained and how melted. The analysis was unusual for a chill of 1½, as shown. It would also be better if the origin of the latter was put on the Paper. He had no wish to rob anyone of the honour of producing such a figure.

With regard to chromium, he personally had done very little except with a much higher percentage than that mentioned in the Paper by Dr. Donaldson, who had some bars of his which he wanted the author to try out. In that material there was a definite softening action on the structure without any graphitisation at all, but the material could be turned, but he doubted whether in the case of Diesel-engine cylinders or other similar parts which are comparatively straight and where there was no part temperature the middle and top portions would be free from trouble and whether there would not be some free-wearing part.

Nickel was being used by him for special purposes, and he knew that in the case of cylinders for air compressors which had to withstand a pressure of 3,000 lbs., whereas with a specially refined iron bad results were obtained, the addition of 1 per cent. of nickel enabled castings to be obtained which indicated no leakage under this test. He knew very little about ordinary grey iron and the addition of nickel, but he had in his possession some samples containing 13 per cent. Monel metal, which had been for 12 months under conditions of alternate wet and dry, and this had had a great influence in preventing rust.

Mr. H. J. Young said that Mr. Donaldson's Paper was a continuation of the series started by that author some years ago, and which constituted, as he had suggested on a previous occasion, a cast iron research association in itself. It represented some of the most valuable work ever done, particularly because Mr. Donaldson never tried to prove what he wanted to be true.

but merely offered such facts as he believed he had proved as the result of exhaustive and accurate observation. The present Paper drew attention to a fact which may prove important in relation to Diesel and internal combustion engines, namely that the addition of chromium increased the thermal conductivity by about 8 per cent. He (the speaker) had remarked previously that probably the greatest benefit from alloy additions would arise only when those additions were combined with the Lanz Perlit Process. At the moment he saw no reason to think that that prediction would not be realised.

"Sulphur-Manganese Balance."

As regards the Paper on manganese by Dr. Norbury, he noticed that the author when reading his Paper was unable to refrain from using the term "sulphur-manganese balance," but that same term, as far as he knew, did not appear in the Paper itself. Dr. Norbury omitted to mention the work of the present speaker published in 1921, when he coined the expression "sulphur-manganese balance," which he had heard used all over Europe since then. That particular Paper stated: "Irons in which the sulphur content is not more than balanced by the manganese content are relatively weak and hard, and possess poor foundry properties as compared with irons similar in composition other than that the sulphur is properly balanced. . . . From a tabulation of some thousands of results obtained in actual practice the author has found no exception to the rule, that the weak or faulty member of two irons of very similar composition is that one where the sulphur content is inadequately balanced by the manganese content. . . . Table VII (reproduced) gives a typical selection of bars with varying sulphur content, and affected only by the amount of manganese balancing the sulphur.

Table VII.

Transverse strength. Lbs.	Carbon. %	Silicon. %	Phosphorus. %	Sulphur. %	Manganese. %
2,342 ..	3.43	1.17	0.60	0.231	0.23
3,533 ..	3.47	1.27	0.61	0.220	0.41
2,025 ..	3.39	1.67	1.12	0.176	0.27
3,494 ..	3.40	1.64	1.08	0.172	0.49
2,352 ..	3.37	1.56	1.21	0.137	0.28
3,553 ..	3.35	1.52	1.15	0.132	0.44
1,747 ..	3.45	1.65	1.08	0.122	0.27
3,791 ..	3.41	1.62	1.05	0.129	0.51
2,223 ..	3.40	1.72	1.15	0.110	0.25
3,672 ..	3.38	1.73	1.14	0.112	0.58
3,732 ..	3.37	1.73	1.01	0.116	0.40

"The author . . . offers these practical results and observations as something better to work on, something impersonal and more scientific. . . . For the moment, therefore, we may take it that there does exist a very vital equilibrium point between the sulphur and the manganese. . . ."

Anyone, particularly a research-worker, can see from the figures of Table VII what the excess of manganese over sulphur has got to be. For instance, an iron containing as much as 0.220 per cent. of sulphur gave the high transverse strength of 3,533 lbs. when the manganese was only 0.19 per cent. in excess. In all the other cases it so happened that the excess was about 0.3 per cent., and the speaker wrote as follows:—"It is to be most clearly understood that the examples are extremes, and that the nearer one gets to the critical point of equilibrium the more difficult does it become, by chemical analysis, to detect any difference between the two irons—but the physical properties remain either very good or very bad right up to each side of the equilibrium."

That Dr. Norbury should have overlooked this evidence and not even mentioned it may explain the redundant quality of much in his Paper. The speaker was unable to accept the author's statement concerning the graphitising action of manganese when it occurs up to 0.3 per cent. in irons containing only 0.01 per cent. of sulphur; why should it not be the effect of the manganese upon the sulphur, and did not the whole of the evidence point that way? In his Series B the author showed that an iron containing 0.03 per cent. sulphur and 0.06 per cent. manganese has 1.29 per cent. of combined carbon, but when the manganese-sulphur balance is corrected, namely, when the manganese is raised to 0.24, the combined carbon falls to 0.90 per cent. Moreover, an increase of manganese to a total of 0.43 per cent. lowers the combined carbon by only another 0.06 per cent., which is within analytical error. How then can Dr. Norbury talk about the graphitising action of manganese when all he did was to correct the balance between it and the sulphur?

Nor can the speaker accept Dr. Norbury's work where he distinguishes between iron sulphide and manganese sulphide by its colour under the microscope. That would need a research in itself, and a very difficult research it would be to carry out in an entirely unprejudiced manner on the cast irons of commerce.

Graphitising Action of Manganese.

It was to be noted that Dr. Norbury appeared to agree with himself and his opposites at one and the same time, for he states that the graphitising action of manganese occurs only in low-manganese irons (containing 0.01 and 0.03 of sulphur), and almost in the same sentence says that the presence of only traces (0.01 per cent.) of sulphur is sufficient to prevent graphitisation. The truth seemed to be that low manganese had no graphitising action whatsoever, but that mere traces of sulphur prevented graphitisation. That truth will not be entirely proved until work is done upon cast iron containing no sulphur at all.

Then, again, Dr. Norbury failed to observe the effect of high manganese, say, 1.5 per cent., where in large castings it caused a coarsening of the graphite, an effect known for many years past to those in control of a wide variety of work. Very large quantities of castings had been made by the speaker which contained manganese from 0.75 up to 1.75 per cent., and apart from the coarsening of the graphite and the greater heat-resisting properties of the iron there was no other effect. This was true with one exception, namely that if there was a chill inserted in the mould its chilling effect would be affected by high manganese content of the cast iron. In his summary Dr. Norbury presented several claims which in no way appeared to be justified by the work in the Paper. As an instance of this might be taken the following:—"A low-manganese grey iron containing hard spots of cementite in a pearlitic-matrix should show good resistance to most types of wear." There did not appear to be one iota of evidence in this Paper to prove anything of the kind, nor did Dr. Norbury say whether he was speaking of grey or of partly white iron. For example, one might make three cast irons, each containing the same amount of cementite in a pearlitic matrix, but one containing 0.3 per cent. of manganese, another 0.6 per cent., and the third 0.9 per cent. Which would wear the best? Would it be the one with the last manganese, and, if so, why?

Mr. Young said his own Paper of 1921 pointed out the poor mechanical and foundry properties of cast irons where the manganese-sulphur balance was faulty, and also presented figures to show that 0.2 per cent. excess manganese was sufficient to balance the sulphur. It might be pointed out that Series A and Series B given in Dr. Norbury's Table I appeared to confirm this, although Dr. Norbury later speaks of 0.3 per cent.

It would appear likely that the author spoiled his Paper by including too much in it. Chill rolls, grey-iron castings, wear-resistance, corrosion resistance, mechanical strength, shrinkage, black-heart malleable and white-heart malleable were eight huge and separate subjects, and those who were saturated with one or the other of them were disinclined to accept a few isolated tests as proving all the many things presented here.

Nickel in Diesel-Cylinder Iron.

Concerning Dr. Everest's Paper, Mr. Young said the author was always an optimist, and he, the speaker, admired optimism. Few things would be either purchased or sold without it no matter what their nickel content. The other day at a meeting of leading metallurgists and head-foundrymen one of them stated that the use of from 0.5 per cent. to 1.0 per cent. of nickel has reduced the waster castings from 10 per cent. down to 5 per cent. or less. The difficulty arose when another equally good man from an equally good foundry gave a flat denial to that statement. It was exceedingly difficult to prove these things, but, nevertheless, it did appear likely that nickel used with scientific judgment will prove valuable to some foundries. He, the speaker, knew of foundries turning out automobile cylinders by the thousand with very few wasters and no nickel; equally did he know of other foundries having many failures in those same castings. If nickel helped the latter people one need not worry about the former; the market price of the product would decide. He would much like "to have a go" at locomotive cylinders with the help of nickel. Granted that the locomotive cylinder people—some of them—appeared to use any cast iron which their cupolas liked to serve up from one day to another; but apart from that it represented a casting where the last word had yet to be said, and the use of nickel might prove not only invaluable to the founders, but extremely helpful to the unfortunate machine and testing shops on that work. Dr. Everest suggested using Diesel-cylinder iron for automobile cylinders by alloying the former with nickel, but that entirely depended upon what Dr. Everest called Diesel-cylinder metal, and one would think that a foundry making those two types of castings would find some other expedient. However, all knew what Dr. Everest meant. Nickel in cast iron was to have its opportunity, and nobody would like to have the chance of experimenting with it in certain directions more than the speaker.

Ratios of the Elements in Irons.

Mr. F. J. Cook, speaking particularly with regard to Dr. Norbury's Paper on manganese, commented on the fact that in the discussion on the previous Paper Mr. Shaw had indicated that he did not agree with him. He had, however, been used to being disagreed with for about 30 years, but from time to time he found evidence that probably he was more right than some of those who disagreed with him, and he rather felt that Dr. Norbury's Paper was in the same category. Many years ago he was engaged in trying to get out ratios of the various elements in high-class irons—for which he had a weak spot—and he had tried to ascertain in a workshop manner the ratios of the various elements for different classes of work. This work varied in weight from a few hundredweight to many tons, and from ¾ in. thick to 1¾ in. thick for steam cylinders, and in order to obtain good wearing properties with these castings it was necessary to get away from porosity in the bore where the valve chest joins. There were generally two chills where the valve chest joins the body, and four others on the centre line where the pressure of the piston comes. He soon found there was a difficulty in avoiding hardness, due to the chilling action, and he was fortunate in finding out very quickly that manganese was the element that was causing the trouble. As a result he got out a balance which he had mentioned several times. The figures he arrived at were three times the sulphur with

a maximum of 0.4 per cent. in this particular case, the silicon being 1.2; the sulphur, which was one-tenth of the silicon, as he had pointed out earlier during the morning, being 0.12 and the manganese 0.4. That seemed to give the best results. If he exceeded that percentage of manganese there was a tendency to chill. Having obtained that balance he never had any more trouble with chilling, and the result was due to the control of the quantity of manganese which Dr. Norbury's Paper seemed to prove. Dr. Norbury might have gone farther, because there was another factor which must be borne in mind, viz., the question of mass. So far as the work he had just referred to was concerned, it had dealt with castings from ¾ in. to 1¾ in., but in the case of hydraulic cylinders having thicknesses up to 4¾ in. there was a graphitising action up to 0.7 per cent. manganese, and in the case of chilled rolls up to 1 per cent. and more. Therefore, the mass action of the quantity of material being used must be taken into account, and if Dr. Norbury would continue his work and give graphs for three ranges of work, it would be extremely valuable for foundrymen generally. Recently he had come across some very peculiar phenomena in connection with manganese in relation to semi-steel cylinders in which there were large patches of glazed surface, which ranged from 4 in. to 1 ft. in length. Out of 151 cylinders, a large proportion showed this phenomenon in varying degrees. On investigating the cause of this trouble, he found that in every case where the manganese was less than 0.3 per cent. difference between that and the silicon, this phenomenon was apparent. At about 0.3. per cent. manganese, slight traces of this effect could be seen, and where the manganese equalled the silicon, it was very badly marked. On etching, these surfaces were found to be simply one mass of manganese sulphide. By making the manganese 0.5 per cent. below that of the silicon there was not a single instance where the trouble mentioned occurred. He did not know whether Dr. Norbury had any explanation to offer for it. Of course, he was aware of the differences in the melting temperatures, but it was a very striking phenomenon. Within a very short time of having to deal with this difficulty he encountered another one in regard to the cylinders and valve boxes for ammonia-compressors for refrigerating work. In this case the silicon was 2 per cent., and as this quantity had a tendency to give open porous places in the thick parts, this trouble was overcome by increasing the manganese in relation to the silicon. The method of increasing the manganese was by the addition of ferro-manganese to the melt, and as this was done in a more or less rule-of-thumb method the manganese had increased till it amounted to about the same content as silicon, *i.e.*, 2 per cent. At this juncture porosity had been experienced, and large glazey patches were noted on the machined faces, when, however, the manganese was reduced to 1.5 per cent., the glazed surfaces disappeared and porosity improved. If Dr. Norbury could give any scientific reason for this he would be extremely thankful, because at the moment he could see no reason for it unless it was a question of the melting temperature.

Referring to Dr. Donaldson's Paper, particularly as regards Diesel engine work, Mr. Cook said he was a convinced believer in the stabilising effect of chromium, and he had used it on many occasions, up to 0.5 per cent., and found it exceptionally good for wear under heat conditions.

Commenting on Dr. Everest's Paper on nickel, Mr. Cook said he was one of the committee which drew up the programme of work in this connection, and he could bear out the remarkable lowering of the chilling effect by the use of nickel. As a matter of fact, Dr. Everest could have given even more striking examples than those he had mentioned in the Paper, and one was an ordinary air-cooled motor-bicycle cylinder, the fins of which were absolutely white when ordinarily cast, but by adding nickel these all became grey, and yet the hardness in the bore of the cylinder was increased.

Mr. R. F. Harrington (American Foundrymen's Association) asked for information with regard to the elimination of shrinkages in such straight-line cylinders as those for Diesel engines.

Mr. E. Longden asked Dr. Everest for information as to the cost of adding nickel to cast iron. With regard to Dr. Norbury's Paper, he said he had been carrying out experiments and was wondering whether Dr. Norbury could tell him exactly the effect of adding 0.35 per cent. manganese to a metal containing 2 per cent. silicon, sulphur 0.15 per cent., and the usual amount of carbon in grey iron. The practical result was that the metal was absolutely unmachinable.

Mr. R. S. Macpherran (American Foundrymen's Association) said he had found nickel has an indirect effect in making iron harder, but the addition of plain nickel to any particular metal he had not found had any decided effect. He would therefore like Dr. Everest, if he could, to differentiate between the direct and the indirect effect of the addition of nickel.

AUTHORS' REPLIES.

Dr. Donaldson, replying to the discussion, said he was glad to hear that Mr. Cook's practical experience confirmed the results that he himself had been able to obtain in the laboratory. As to Mr. Young's remarks on the increase of thermal conductivity on the addition of chromium, the work described in the Paper was carried out in order to obtain data for Diesel engine work, and it might be interesting to state that the chromium and tungsten of the metals investigated were the only ones which increased the thermal conductivity. With regard to Mr. Shaw's question concerning the test-bars he had provided, these contained 1 per cent. of chromium and 1 per cent. of nickel—a higher percentage of chromium than he had experimented with—and in each case the stabilising effect of chromium was maintained after heating for 200 hours at 150 deg. C. There was no change in the combined-carbon content or the Brinell hardness. At the same time, the 1 per cent. of nickel did not lessen the stabilising effect of the chromium and it rendered the iron more machinable.

Mr. Shaw suggested that the method adopted by the author of heating up was not true annealing because the metal was heated up during the day and allowed to cool during the night. Ordinary annealing was more or less rapid heating and cooling, and that was where the softening effect came in.

Dr. Donaldson suggested that the softening was due to the presence of nickel.

Mr. Shaw remarked also that whereas the author stated he did not find the Brinell was lowered, he himself had found it was seriously lowered.

Dr. Donaldson said that was probably due to the difference in treatment, the method adopted by Mr. Shaw being true annealing and the other a heat-treatment process.

Dr. Norbury, replying to the discussion so far as his Paper was concerned, said Mr. Field had referred to the lower shrinkage of Derbyshire pig-iron as compared with Northamptonshire pig-iron, and suggested that it was due to the higher manganese. That was probably the case. Mr. Shaw was quite right in disowning two of the chill diagrams on page 19, and the difference between these and the other two diagrams was due to the fact that they were cast from synthetic melts of Swedish white iron, Armco iron, ferro silicon, etc. Synthetic melts made in a certain manner could be made to give much greater depth of chill than ordinary cupola melts. The effect of manganese on sulphur was, however, the same in the two cases. Mr. Shaw wanted him to experiment with thicker sections, but his point of view at the moment was that a more important problem to solve was to find out where the missing manganese went to and exactly how it distributed itself between the sulphur and the other elements present, and then they would be able to understand what happened in thicker sections. He would, however, carry out experiments on the lines indicated by Mr. Shaw. At the moment his impression was that with thicker sections, which cool more slowly, less manganese would be required to neutralise whatever sulphur was present, and not more manganese. The case would be more comparable with the annealing of malleable iron, where less manganese was required, because the manganese can diffuse and get to the sulphur and neutralise it. He apologised to Mr. Young for not referring to his work, but so many people had done work on this subject that it was not possible to refer to them all. He also had noticed, as Mr. Young and Mr. Shaw had done, the risk of coarse graphite in high manganese irons. In the cases in which he had noticed it, it was because the ferro-manganese which was added contained 6 or 8 per cent. of total carbon, which, of course, increased the graphite content and made the iron very open and of very coarse grain. He did not know any other explanation to offer to Mr. Cook in respect of some castings of his with very marked manganese sulphide segregations than that the higher the manganese to sulphur ratio the higher would be the melting point of the sulphide and the higher would be the temperature at which it separated out, consequently the greater the possibility of it segregating. Mr. Longden had stated that a metal containing 0.35 manganese, 0.15 sulphur, 3.2 per cent. total carbon, and 2 per cent. silicon was white when sand-cast in the form of a 1-in. diameter bar. He would have expected it to be grey, but the low manganese and relatively high sulphur would increase the tendency to form hard spots and chill.

Dr. Everest, replying to the discussion on his Paper, mentioned first the point raised by Mr. Field as to the possibility of the use of nickel in high-silicon iron. At present, he said, we do not know very much about the influence of nickel in irons which are predominantly ferritic. However, the point really was, not the silicon content of the iron, but rather the amount of combined carbon present in the casting, that was of importance, since nickel acts predominantly on pearlite rather than on ferrite. There were cases in which, with silicon as high as 3.0 per cent. in engineering castings, nickel up to 2.0 or 3.0 per cent. could be beneficially added. Such a case was a thin-sectioned casting for a light piston skirt, which in the cast condition was only about $\frac{1}{10}$ of an inch thick, and in such a case nickel could be used to advantage in obtaining a uniform and machinable casting. Again, the case of resistance grids might be cited when, even in the presence of high silicon, 3.0 or 4.0 per cent. of nickel could be added to obtain a tough, strong casting. This did not refer, however, to the special case of resistance grids with higher nickel contents, where the nickel was used to confer special electrical and magnetic properties on the iron. He took exception to the suggestion that nickel was to be put forward as a "cure-all." It was definitely not. Nickel would improve a good iron, but it would not necessarily render a bad iron good.

Mr. Macpherran referred to wear tests on cast iron. The author did not attach much importance to accelerated laboratory tests on wear, as there were no means by which the conditions of wear inside a cylinder, say, of an automobile engine, could be reproduced. It was impossible to reproduce the conditions of lubrication, the correct bearing-pressure, speed, reciprocation, etc., and in the wear of cast iron it was a matter of general experience that any change in one of these conditions might totally alter the results. If one took a soft iron and worked it under a given load, the surface would become

glazed, and a long service could be obtained with little apparent wear. If the load was increased a little more, however, then the conditions were often entirely upset and a rapid wear would very likely be initiated. It was suggested that this was a problem in the automobile industry to-day, for there had been an increase in the power output of engines, with consequent increase in compression ratios, bearing pressures, and so on, with the result that soft irons which up to the present had been perfectly satisfactory were now showing bad wear. This was no doubt in great measure the contributory cause to the interest which was at present being taken in improved material in automobile engine construction. Mr. Macpherran also referred to a nickel : silicon ratio of 2 to 1. It was generally found, however, in this country that for the range of compositions normally employed in engineering castings, that 3 parts of nickel were equivalent to 1 part of silicon in reducing chill in a cast iron. This ratio, however, would not be considered to hold definitely for abnormal silicon contents already on the low or on the high side.

Mr. J. Longden raised the question of the possible improvement in soundness which might be obtained in gear-blank castings by the use of nickel, and mentioned an experiment in which he added 2.0 per cent. of nickel to his ordinary iron, which contained 1.3 per cent. of silicon. Porosity was found at the base of the cut teeth in these gears, and the nickel addition had proved ineffective in removing this. The author pointed out that the 2.0 per cent. of nickel added was equivalent to about 0.7 per cent. of silicon with regard to the graphitising action in the iron, consequently he was really casting his gear-blanks with an equivalent silicon content of 2.0 per cent., which would be expected to give too soft and open an iron. The author pointed out that especially for the elimination of porosity the maximum benefit of nickel was obtained when the silicon was reduced by an amount equivalent to the nickel addition. For the gears in question he would suggest that a composition showing 1.0 per cent. of silicon with 1.0 per cent. of nickel would be very likely to show an elimination of this porosity.

This point connected up with the question raised by Mr. Harrington. He agreed broadly that in the elimination of porosity the reduction in silicon was perhaps the crux of the situation, and that it was due to this that improvement in soundness was often obtained. The function of the subsequent addition of nickel was to restore the machinability and toughness of the casting, without opening up the structure again as a further addition of silicon would have done.

Mr. Harrington (American Foundrymen's Association) said he was glad Dr. Everest had pointed out that fundamentally the reason for the improvement with the use of nickel was in the reduction of silicon, but his own observations suggested that something more than that happened. There must be a change in the elements other than the silicon, and he agreed that nickel could not be regarded as a cure-all, because it was not.

The author said he did not agree with Mr. Harrington that this improvement was due to incidental changes in the amount of the other elements present. On the other hand, the author wished to say that many cases had come to hand in which porosity had been effectively removed by the addition of nickel, without any change being made in the composition of the iron that was in use, even though nickel added in this way was not recommended for the specific purpose of eliminating porosity. This was at the moment difficult to explain, and all that could be said was that there appeared to be a refining action of the matrix in the iron which seemed to give a close-grained structure, showing greater uniformity in the castings. Referring to the inquiry as to the use of nickel in simple cylindrical castings, it was said that experiments had been carried out on piston-valve-liners for locomotive work, and nickel had proved effective in eliminating porosity in these castings. In this country many castings of this type would be made centrifugally, and the question of porosity would probably not then arise. This was the tendency to-day, particularly in connection with the automobile industry.

Mr. H. J. Young raised the question of locomotive cylinders. This was a problem in itself, but it was of special interest in that it was generally known that there were certain designs of locomotive cylinders which would practically never give a sound casting, and caulking was in this case almost inevitable. Some experimental work in this field had been initiated, and the results obtained up to the present were very promising, and the author was most optimistic about this application of nickel. Cylinder-covers for locomotives, which carried a heavy boss to which a guide rod was subsequently attached, had given a great deal of trouble with porosity through the cover, at the root of this boss. In one case twelve of these covers were ordered off a certain pattern, and made in ordinary iron. The whole set were scrapped on account of leakage. Satisfactory results have, however, been obtained by reducing the silicon by about ½ per cent. and adding 1.0 per cent. of nickel, and up to the present every cover had passed its tests.

Referring to the question of Diesel iron for automobile cylinders, it has been found in certain foundries making cylinder castings for both purposes, that the low-phosphorus, low-silicon Diesel iron had proved a very effective basis for the addition of nickel for automobile work. The Diesel iron in question would be for small castings and would carry about 1.3 per cent. of silicon, and an addition of 1 to 1¼ per cent. of nickel was made to this for automobile work.

Dr. Everest thanked Mr. Shaw and Mr. Cook for their sympathetic remarks and for the examples they had mentioned in support of the statements made in the Paper.

Chromium Reduces Sea-Water Corrosion.

Mr. F. Hudson, commenting on Dr. Donaldson's Paper on "The Influence of Chromium in Cast Iron," wrote that the industry was much indebted for the very valuable work done by Dr. Donaldson in this and other Papers he has published. For his own part he was particularly interested in the results obtained from corrosion tests, and especially those relative to the milder forms experienced in the handling of sea-water, river-water and tap-water flowing through pipes and valves in the various public service and industrial plants of to-day. The need for corrosion-resisting cast irons was probably greater than that of non-growing cast iron. Corrosion tests conducted by Messrs. Glenfield & Kennedy relative to alloy-additions to cast iron confirm the results obtained by the author. The results obtained, in brief, point to the fact that the harder and closer-grained the cast iron then the greater the resistance to corrosion by sea-water. For example, semi-steel mixtures are superior to soft iron mixtures, and the additions of alloys which increase the combined carbon, such as chromium, reduce corrosion. Nickel, on the other hand, increases corrosion in sea-water. In regard to river-water, the difference between various quality cast irons with and without alloy additions, is not nearly so apparent. In regard to corrosions by acids, conditions are very often opposite. It would appear, however, that the addition of chromium is certainly of benefit to lessen corrosion by sea-water.

Dr. Donaldson wrote that he thanked Mr. Hudson for his contribution to the discussion. It was extremely interesting to know that tests carried out by him confirmed the corrosion results obtained with the various chromium additions. He could also confirm his remarks regarding the resistant powers of hard close-grained irons to sea water. This was experienced when experimenting with low-silicon (Perlit) irons, and irons containing tungsten additions.

Resistance of Nickel to Corrosion.

Mr. E. J. L. Howard wrote that he had read Dr. Everest's Paper with considerable interest. His remarks *re* accelerated corrosion and mechanical erosion tests being of little value were only correct to an extent. Valuable information of a comparative nature could be obtained if suitable methods of testing were adopted, that is, methods which would as nearly as possible represent the conditions for which the material was required. The resistance to abrasion or mechanical erosion may be readily tested by rotating discs of the material under test in the abrasive media, and it has been found that tests made under these conditions and the actual service tests have approximately the same figure, and are an indication of the suitability of the material for a definite purpose.

Corrosion tests, of course, could only be comparative. The addition of nickel alone does definitely increase the resistance of iron to mechanical erosion, and this increased with the amount of nickel added, up to 3.5 per cent., but better results were obtained with a simultaneous addition of about 0.5 per cent. of nickel and 0.5 per cent. chromium.

Resistance to corrosion did not seem to be materially affected by small additions of these alloys. It was his experience that cast iron with the nickel addition alone was rather more viscous and did not tend to retain entrapped gases, causing blow-holes, unless considerable care was taken. These difficulties appeared to be overcome if a combination of nickel and chromium were used, especially if the additions were made through the cupola. He had always found the iron to which additions had been made through the cupola was definitely better than one to which additions had been made in the ladle or spout of the cupola. Was this Dr. Everest's experience, and, if so, could he offer any explanation?

It was interesting to note that nickel additions do not have a marked effect on the test-bar results, but the engineer, who is probably the chief consumer of cast iron, was not so concerned with the strength of cast iron as an improvement for resistance to wear, mechanical erosion and corrosion.

Wherever anything stronger than the average cast iron was required, he usually used steel, either as a casting or a forging. The addition of nickel to cast iron for couplings was surely an expensive method, and one would imagine troubles due to porosity could be overcome by correct methods of moulding.

He would be interested to hear if Dr. Everest had any information regarding the effect of higher percentages of nickel or nickel and chromium for withstanding corrosion. Also if there was any advantage to be obtained in the use of some form of heat treatment of these alloys.

Author's Reply.

Replying to Mr. Howard, Dr. Everest stated that, in his remarks on the value of accelerated corrosion and wear tests, he had in mind primarily tests in which, to obtain measurable effects in a minimum of time, conditions were used which were not strictly comparable with those occurring in normal service. It was under these conditions that little reliance could be placed in the results of such tests. In a test such as the mechanical erosion test described by Mr. Howard, service conditions were more nearly reproduced, and consequently the results were undoubtedly of greater value.

The author was very interested in Mr. Howard's note that the addition of nickel alone increases the resistance of iron to mechanical erosion, but would point out, however, that the suggested addition of about 0.5 per cent. nickel and 0.5 per cent. chromium would markedly increase the tendency of the iron to chill, and for this reason could not be recommended for general purposes. One-half per cent. of chromium would require in usual conditions a simultaneous addi-

(*Continued on page* 106.)

The Influence of Size of Section on the Strength of Grey Cast Iron.*

By J. G. Pearce, M.Sc., M.I.E.E.

[BRITISH CAST IRON RESEARCH ASSOCIATION.]

Introduction.

The author has previously suggested† that there is a continuous change in strength of cast iron as the section alters, and that the transverse test is a cheap and simple method of following this change, provided the results are expressed as transverse rupture stress and not merely as breaking load. The experiments on which these conclusions were based were somewhat limited in scope, the sizes of bars used being largely the three specified in B.E.S.A. Specification 321 for grey iron; 2.2 in., 1.2 in. and 0.875 in. diameter round bars. The interest they aroused has enabled the author to obtain data on a wider range of sizes and compositions, and although the whole of the work in progress is not yet completed, some further points of interest have emerged.

If a cylindrical transverse bar is cast and tested, the transverse rupture stress R is readily obtained by the usual formula $\frac{2.5\ WL}{d^3}$ where W is the central breaking load, L is the span, and d in the diameter. If W is in tons and L and d in inches, R is in tons per sq. in. In all tests recorded below, unless otherwise stated, L is 21 in. Heavy bars do not give a suitable deflection at the usual 12 in. and 18 in. spans recommended in B.E.S.A. Specification 321. In view of the slight change in rupture stress with span it seems desirable that this should be standardised for all sizes of test bar.

If a pig-iron is melted and a set of separately-cast, cylindrical bars made of varying diameters, the strength of the bars can be related to the size, as shown in Fig. 1, where the line AB represents a mean curve drawn through the actual points showing the transverse rupture stress at various diameters from 0.8 in. to 4.7 in. As would be anticipated, the smallest bar (0.8 in. diameter, which remained grey) was strongest (just over 35 tons per sq. in.), and the larger bars became progressively weaker per sq. in. of their section, 4.6 in. bar being only 22 tons per sq. in. AB is the size-strength curve for the particular mixture and set of melting conditions employed.

Influence of Machining.

The author has previously suggested that although the skin is normally the strongest part of a casting, the increase in strength following on skin-machining may be due to the fact that minute fissures and skin cracks result in premature fracture when the bar is tested as cast in transverse. In Fig. 1 the curve AB referred to above represents the strength of a set of bars tested after skin-machining, while CD represents the strength of a set of bars cast from the same metal at the same time from the same patterns, but tested as cast. The actual figures obtained for the various bars of the unmachined set are shown by the broken line as well as the mean curve CD. The amount removed in machining varied from 0.02 in. to 0.05 in. It will be noticed that the machined series is the stronger, the difference being about 8 per cent. Further machining would doubtless have shown a reduction in strength, the amount depending on the composition and structure of the metal, for some irons weaken towards the centre more rapidly than others.

The favourable effect of skin-machining is, of course, well-known, but this case is quoted because the points representing the strengths of the machined series lie much more closely on the curve than those of the more erratic unmachined series. In other words, the variations from the mean are less pronounced in the machined than in the unmachined series. Local heterogeneity and other differences inevitable in ordinary cast iron, as well as slight variations in testing procedure, cause slight variations from the expected even on machined bars, but there is no doubt that more uniform results are obtained from skin-

MR. J. G. PEARCE.

machined bars, and the difference shown in Fig. 1 has been repeatedly confirmed for other series of bars. The remaining tests given in the paper, unless otherwise specified, refer to skin-machined bars, and the strength given is based on the tested diameter taken at the fracture. There is much to be said for testing machined in preference to unmachined bars, and the use of the round test bar renders this a much more practicable proposition than was the case for the old square or rectangular bar. In the series shown in Fig. 1, tested as cast, a 0.5 in. diameter bar is included, and the fall in strength on this is probably due to mottling. It is particularly difficult to determine whether mottled or white iron is or is not actually stronger than grey iron because of its brittleness. Analysis is given in Table I.

It was possible to obtain a set of bars made from iron very similar in general character to that used for the bars in Fig. 1, except that the phosphorus was slightly increased. The result is given in Fig. 2 as curve B, and for comparison the curve AB of Fig. 1 is reproduced as curve A. The two irons differ, as will be seen from the analyses of Table I, only slightly in the other elements.

Influence of Melting Conditions on Strength.

Dr. A. L. Norbury has recently shown* in the laboratories of the British Cast Iron Research Association that cast irons may present marked differences in mechanical properties in spite of similarity of chemical composition, due to differences in melting conditions resulting in differences in structure. That such differences are experienced in ordinary cupola-melted irons is evident from data given by Mr. W. Jolley,* and indeed the conclusion is borne out by practical experience, for unaccountable differences and anomalies not explained by chemical composition and often ascribed to gases, small quantities of rare elements and so on, are met by most foundrymen. In these circumstances it might appear erroneous to suggest any relationship between composition and strength, and indeed a considerable body of foundry opinion views pessimistically any attempt to relate the two, since these differences occur in castings which have compositions as close together as ordinary practice permits. This in some quarters also has the unfortunate effect of discrediting chemical analysis and the guidance which it can give. It can now be taken as established that the differences referred to are due to differences in melting conditions, and their effect on the metal is not always recognised.

TABLE I.

Curve.	Fig.	T.C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.
1A, 1B, 2A	1 & 2	3.51	1.03	0.61	0.14	0.73
2B	2	3.44	1.13	0.50	0.16	0.95
3A	3	3.55	1.95	0.50	0.08	0.72
3B	3	3.71	1.29	0.62	0.09	0.59
3C	3	3.50	0.68	0.35	0.18	0.64
5A	5	3.16	2.06	0.39	0.14	1.12
5B	5	3.24	1.41	0.56	0.10	0.55
5C	5	3.42	1.17	0.39	0.13	0.60
7A & 7B	7	3.46	1.57	0.45	0.10	0.43

An ordinary foundry melting a similar mixture, say a pig and scrap mixture, day after day in the same furnace, works under a set of melting conditions which is subject only to comparatively minor variations. The product of such a foundry remains, so far as the composition and structure of the metal is concerned, within practical limits, the same. The foundry, however, may unconsciously alter the structure, and hence the strength and other properties of its castings, by introducing a change in melting conditions, even when an attempt is made by scientific mixing to produce the same composition as before; this may arise from an alteration of the brand of pig-iron, by introducing steel into the charge, by the use of foreign scrap of unusual composition, by changing temporarily from one composition of ferro-alloy to another (*i.e.*, from a lean to a rich ferro-silicon), or by changing from a cupola to a crucible or air furnace. The effect of such changes can now, with some measure of accuracy, be forecast. They may affect composition in the absence of scientific mixing, but in any case they affect structure—mainly the size and distribution of the graphite.

TABLE II.—*Analyses.*

	T.C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.
A	3.2	1.37	0.94	0.09	0.18
B	3.5	0.98	1.01	0.09	0.21

An illustration of the differences between irons of somewhat similar composition made in ways which many founders would consider calculated to give similar results was recently furnished by Mr. John Shaw, who kindly arranged for the Brightside Foundry & Engineering Company, Limited, to melt two mixtures in the same cupola and cast them into 1.2 in. (M) and 2.2 in. (L) bars, as far as possible under identical conditions. The first charge was made up of

* A Paper presented to the recent International Foundrymen's Congress.

† "Journal Iron and Steel Institute," 1928, II, p. 73, and FOUNDRY TRADE JOURNAL, January 24, 1929.

* Iron and Steel Institute, May, 1929 (Reprinted FOUNDRY TRADE JOURNAL, May 23, 1929).

* FOUNDRY TRADE JOURNAL, April 4 and 11, 1929.

equal proportions of steel and white iron with enough 12 per cent. ferro-silicon and ferro-manganese to yield a strong grey iron. The second charge was made of the same materials with the exception that 40 per cent. ferro-silicon was used in the place of 12 per cent., the proportion, of course, being altered to give the same silicon content in the melt. Unfortunately the silicon contents differed slightly in the bars, which were tested strictly in accordance with

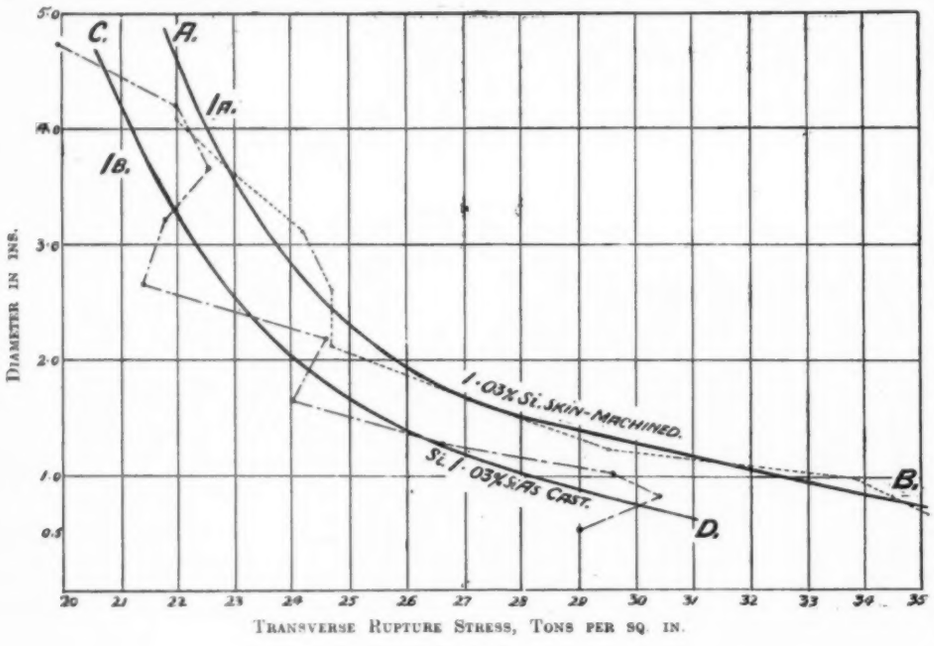

Fig. 1.

B.E.S.A. Specification 321. The results are given in Tables II and III. The combined carbon was about the same, 1 per cent., in each. The difference in total carbon should be regarded as due to melting conditions rather than composition. Micro-examination showed a slightly coarser graphite structure and a rather larger quantity of graphite in B, which is the weaker iron mechanically and the lower in silicon.

Thus a change in melting conditions which many foundrymen would assume would not produce any marked difference in the product is shown to produce a decided difference in strength. This example shows that differences occur in cupola-melted irons as well as in crucible-melted irons found by Dr. Norbury. Criticism directed against attempts to correlate composition and strength is often based on experience in which differences arise from alterations in the melting conditions. If these remain the same comparison is possible, and the illustrations used in the paper are all based on the melting conditions remaining the same for all irons compared on a basis of composition.

It is, of course, not possible to compare, until a good deal more work has been done, strengths of irons produced under varying melting conditions, but from the same raw material a curve of the type shown in Figs. 1 and 2 enables different foundries to compare their melting conditions. Bad conditions give poor results and vice versa. Furthermore, in the same furnace the results of different raw materials can be compared, and so on. No very definite conclusions, however, can be drawn from curves prepared for different raw materials melted in different ways.

Influence of Composition on Strength.

Adhering rigidly, therefore, to one type of raw material mixture and one cupola, size-strength curves have been prepared for irons of varying silicon contents. Fig. 3 shows curves A, B and C for three such irons. It will be noticed that they are approximately parallel, but that a drop of 0.5 per cent. silicon from 2 per cent. to 1.3 per cent. increases the strength less than the drop from 1.3 per cent. to 0.7 per cent., the smaller bars of the latter series being white. In Fig. 4 silicon content has been connected with strength for various sizes of bars, 4 in., 2.2 in. and 1.2 in. being chosen. From this curve can be read off the strength of a cylindrical bar of any silicon content and conversely the silicon required in a given bar to give a specified strength. For intermediate sizes of bars values may be either taken from the size-strength curves or judiciously interpolated.

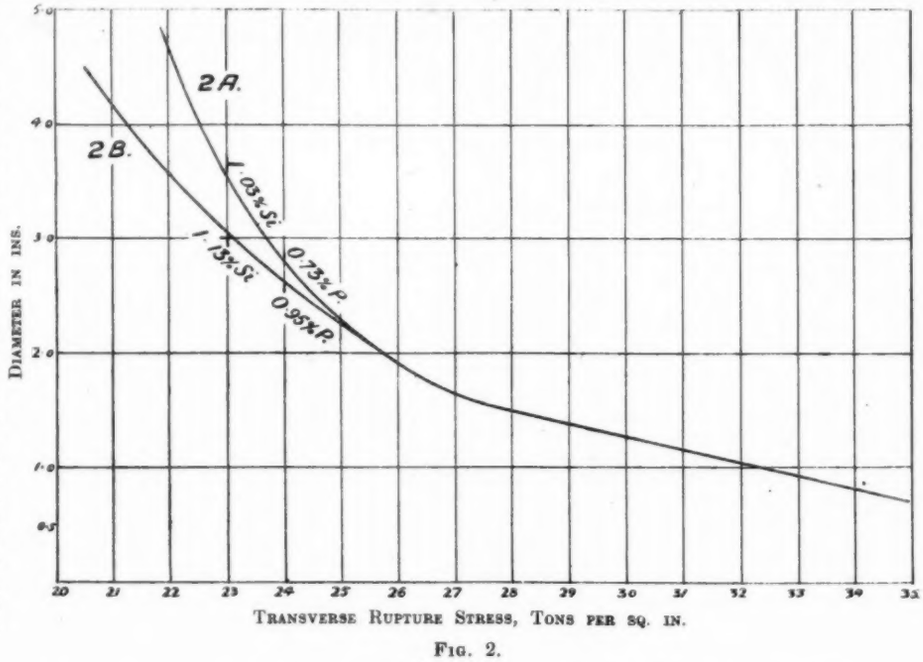

Fig. 2.

In Fig. 5 size-strength curves A, B and C have been drawn for three foundry mixtures of varying silicon contents, analyses being given in Table I. It was naturally not possible to keep total carbon and other elements within the same limits as fixed for irons in Figs. 1, 2 and 3, where only one pig-iron was melted, but here again composition-strength curves have been drawn in Fig. 6 connecting silicon and strength, and the general similarity between the curves in Figs. 5 and 6 with corresponding curves for irons much closer in composition shown in Figs. 3 and 4 will be noted. The reason for this probably is that differences in chemical composition (other than silicon) are of comparatively minor importance compared with differences in melting conditions. Hence the reason for ignoring small composition differences between irons melted under similar conditions, such as those shown in Fig. 3, as well as the more considerable ones shown by the irons in Fig. 5.

On the other hand, when the melting conditions differ, there are considerable differences in strength even where compositions are similar, as may be seen by examining Figs. 1 and 2 and comparing the results with those shown in Fig. 3, and comparing the results of each of these with those of Fig. 5. The comparison is best shown by Figs. 4 and 6 and illustrates the virtue of remelting.

When such differences can arise from factors other than composition it will be appreciated that differences in composition, such as those between A and B in Fig. 2, between A, B and C in Fig. 3 or between A, B and C of Fig. 5, are of comparatively minor importance.

Size-strength curves similar to those shown in Figs. 1, 2, 3 and 5, and composition-strength curves for a given set of melting conditions similar to those in Figs. 4 and 6, have been obtained on a number of sets of bars. Little useful purpose, however, is served by multiplying illustrations which only apply to one set of melting conditions. The aim of the Paper is to suggest a method which enables comparisons to be made between different irons melted under the same conditions and the same irons melted under different conditions.

The transverse test, of course, is only one mechanical test and may offer little guidance as to the ability of the metal to withstand fatigue, fluid pressure, abrasive wear, corrosion or heat.

Tensile and Transverse Strength.

If a series of bars from a cast be tested in tension on the same-sized test-piece, the values will not, under ordinary conditions, depart far

(*Continued on page* 104.)

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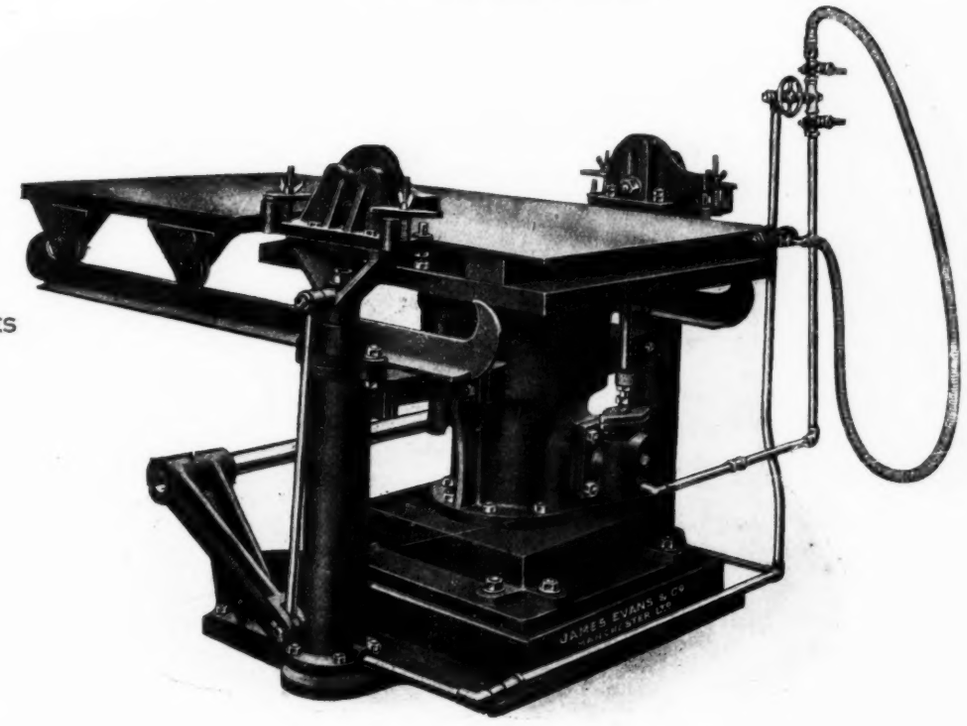

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The above machine illustrates a Jar Ram Machine with Turnover Pattern Plate which can also be used for Stripping Plate Work.

The machine has been designed to combine the two distinct features above mentioned, and is practically two machines in one, equally suitable for steel, iron, etc.

The machine as illustrated is arranged for work that requires turning over, such as steel moulding. And while the turnover arrangements are intended for general repetition work, by detaching the turnover plate from the trunnion brackets the machine can be used for stripping plate work by attaching the stripping plate to the trunnion brackets. Or, on the other hand, by removing the trunnion brackets as well, the table can be used for jolting general jobbing work.

A very important feature of the machine is the simplicity with which the intensity of the Jolt can be regulated when the operator has become accustomed to the use of the machine, which takes but an hour or so. The valves all being on the exterior of the machine are easily accessible, and there is an adjustable arrangement that will allow the jolt to be varied between 1½ in. to below ¼ in. This being done without disturbing any part of the machine.

The machine is supplied with Withdrawal Carriage, Vibrator, and Blow-off Nozzle complete. It is substantially constructed to stand heavy wear and tear, and requires a minimum amount of skill to operate.

Another important feature of the machine is in the arrangement of the hard wood anvil block for receiving the shock. The blocks being carried well down the machine in a specially designed annular chamber give considerable relief to the foundations. It also provides against the possibility of fracturing the jolting table. Pitch pine blocks are also inserted between the foundation plate and the machine bedplate to assist in the relief on the foundations, and these features considerably improve the working advantages of the machine.

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from the mean, and the same applies to transverse tests. For the particular mixture and the sizes of test-bars chosen there will, therefore, be a definite ratio of transverse to tensile strength.

Table III.—*Mechanical Tests.*

Cast.	Transverse—18-in. centres.				Tensile. Tons/sq. in.
	Bar.	Load. Tons.	Deflection. In.	Rup. stress. Tons/sq. in.	
A	M	1.22	0.24	32.4	20.1
	L	6.35	0.19	28.7	16.0
B	M	1.24	0.24	31.3	18.0
	L	6.0	0.22	26.7	14.9

For ordinary irons and the usual standard bars this ratio is about 1.8 to 2. Through the courtesy of Vickers-Armstrongs, Limited, Barrow-in-Furness (Mr. W. Machin and Mr. W. B. Goudielock), the author tested bars of 1.2-in. and 2.2-in. cylinder iron in transverse, averaging three results in each case. The broken bars were then turned to tensile pieces of different diameters varying in the 1.2-in. bars from 1.0 in. to 0.2 in. and in the 2.2-in. bars from 1.9 in. to 0.2 in. The variation in tensile strength with diameter is shown in Fig. 7, A representing the 2.2-in. and B the 1.2-in. bars, and Table I gives the analysis. It will be seen that tensile strength falls off very rapidly as the machined diameter decreases, but that at the specified B.E.S.A. diameter for each size of bar, the tensile strength falls within the range represented by transverse strength divided by 1.8 to 2.0. Clearly the ratio of transverse to tensile depends on the size of the test-piece, and tests on other compositions will enable the influence of composition to be determined. In a set of bars of four compositions kindly provided by Metropolitan-Vickers, Limited (Mr. W. Jolley), a 1.2-in. transverse bar was broken and one half turned to the standard tensile diameter of 0.564 in. and the other to the standard tensile diameter of 0.798 in. The transverse/tensile ratio varied between 1.59 and 2.18, and the question undoubtedly demands further examination. The mechanical tests of the last-mentioned set are given in Table IV.

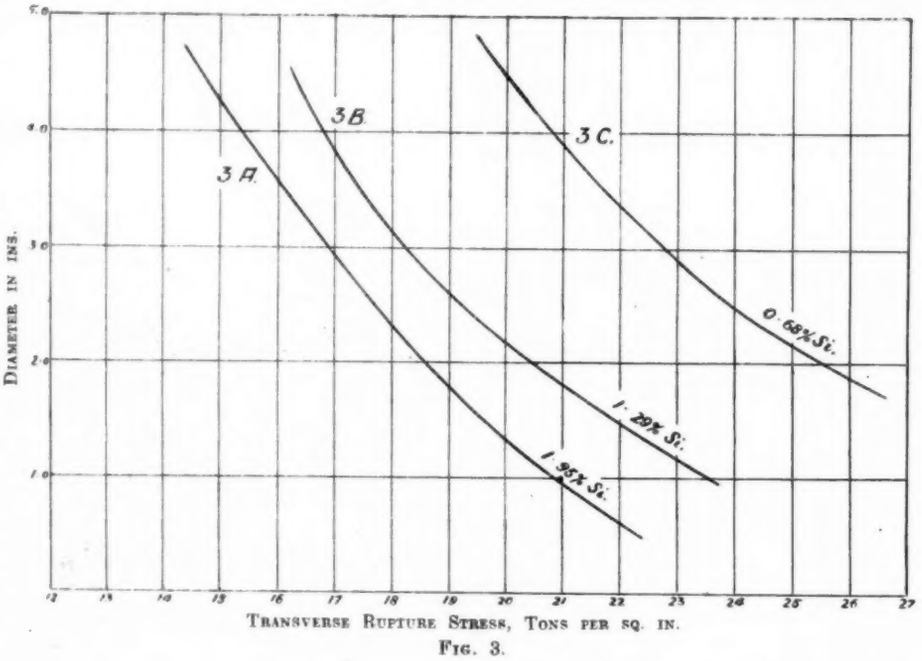

Fig. 3.

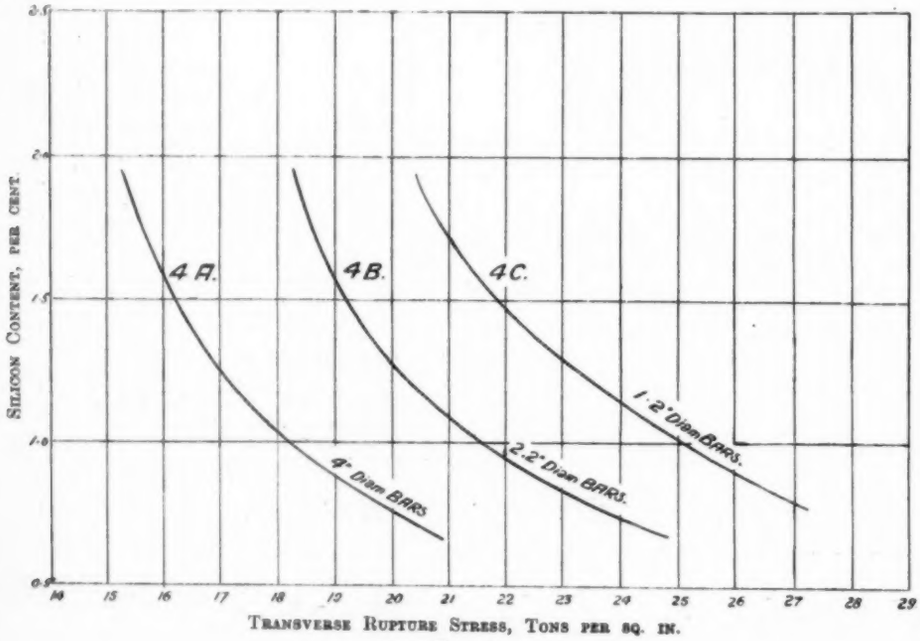

Fig. 4.

Conclusion.

The author would again stress the fact that the curves shown have no general validity and apply only to one type of charge melted under one group of conditions. The aim in view is to suggest a method which will enable a foundry to compare different melting conditions by using the same charge, and to compare different mixtures by using the same melting conditions. Such tests should enable the best melting-conditions to be established, and in some respects this problem is more urgent than that of obtaining good raw materials. It can afford little satisfaction to makers of high-class pig- and refined-irons to have their materials degraded in quality under poor melting-conditions, and the cheaper the grade of pig-iron used the more important does it become to melt it so as to get the best out of it.

The author thanks the Council of the British Cast Iron Research Association for permission to publish this Paper, and, in addition to the acknowledgments made in the Paper, has to express his indebtedness to the Lilleshall Company, Limited (Mr. T. E. Freeston), for the large amount of work willingly undertaken in preparing the bars on which Figs. 1 to 4 inclusive are based, and to Lee, Howl & Company, Limited (Major C. Howl), for similar help in preparing bars on which Figs. 5 and 6 are based.

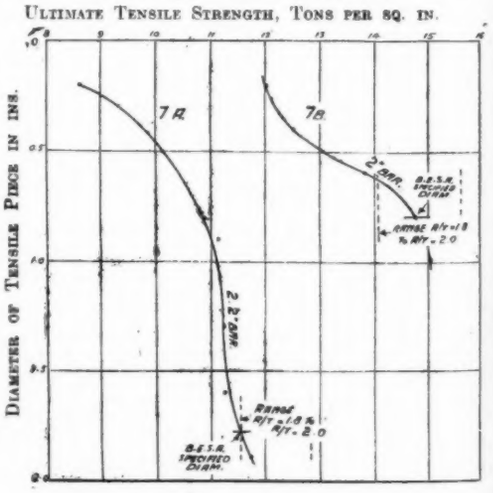

Fig. 7.

Summary.

The strength of cast iron is determined by its composition and its structure, these factors being fixed in part by constitution of the charge and in part by the melting conditions. For a given type of charge melted under the same conditions and poured into a series of cylindrical bars, transverse strength increases continuously as section diminishes. Skin-machined bars are

(*Continued on page* 106.)

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not only stronger than bars tested as cast, but the results are less erratic.

Illustrations are given of size-strength curves for two series of irons, both cupola-melted, one series being pig-irons and the other foundry mixtures. Each series has three silicon contents and its own set of melting conditions. From each set of size-strength curves composition-strength curves are deduced. The curves are of the same type in each series of mixtures.

Table IV.—*Mechanical Tests.*

Mixture.	Transverse R. on 1.2-in. bars, 12-in. centres.		Tensile T. Tons/sq. in.		$\frac{R}{T}$	
	Rup. stress. Tons/sq. in.	Deflection. In.	0.564	0.798	0.564	0.798
S	32.0	0.13	16.04	18.24	1.99	1.76
SS	29.8	0.11	18.76	18.54	1.59	1.61
C	20.8	0.13	9.52	10.00	2.18	2.08
CC	22.5	0.08	13.28	11.8	1.70	1.91

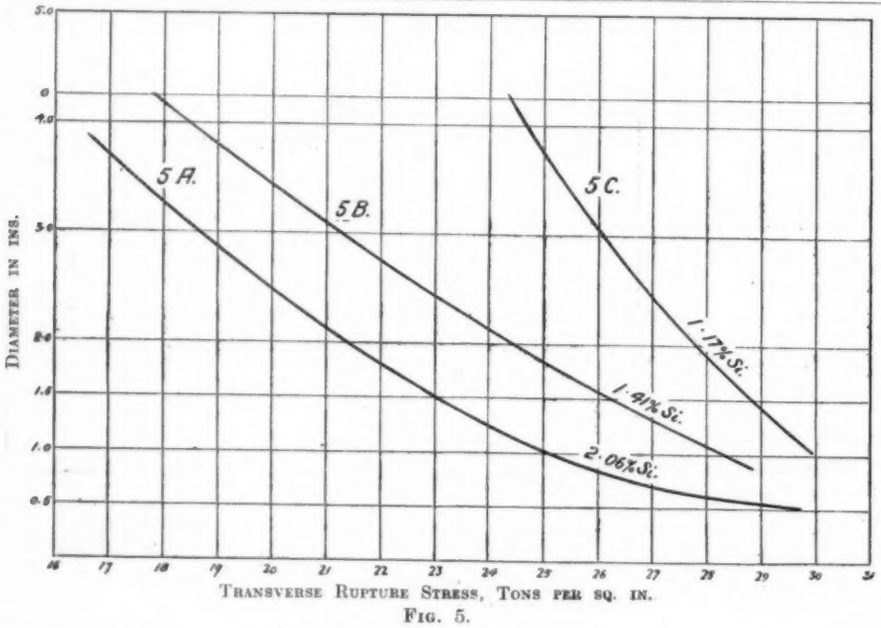

Fig. 5.

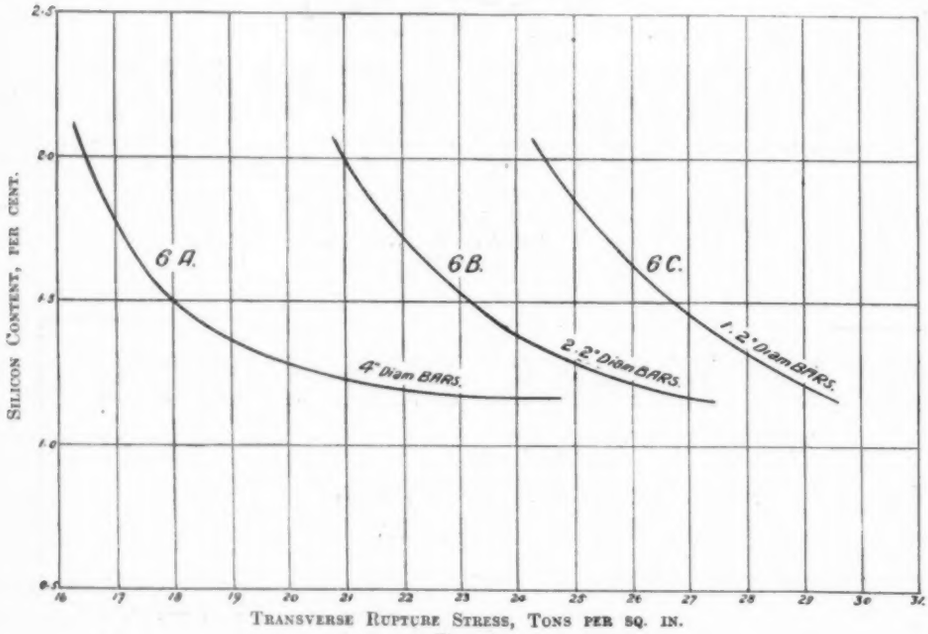

Fig. 6.

For a cylinder iron the ratio of transverse strength to tensile strength is shown to fall within the range 1.8 to 2 for standard B.E.S.A. conditions of testing.

International Views of Alloy Additions in Cast Iron.

(*Continued from page* 100.)

tion of about 1.5 per cent. of nickel to eliminate this effect.

Slight improvement in the resistance of cast iron to chemical corrosion may be obtained through the use of small additions of alloys. In general, however, there is no very greatly marked influence until the addition is large enough to alter the constitution of the casting.

It has not been the author's experience that nickel cast iron is more viscous than ordinary cast iron, and, moreover, experiments which have been conducted to compare the fluidity of these materials have led to the conclusion that nickel cast iron is not generally less fluid than is the ordinary iron. This may be due to the lengthening of the freezing range. In these circumstances no difficulty would be anticipated from the inclusion of entrapped gases in the castings. If the nickel is added in the ladle, then clearly a certain chilling effect will be produced in the iron, balancing the heating up of the nickel. It has been found, however, from extensive experience, that within ordinary practical limits, this chilling effect does not lead to any trouble in obtaining sound castings from the iron. Limits which have been given elsewhere are for the addition of up to 2 per cent. of nickel in a bulk of iron of over $\frac{1}{4}$ ton when the iron is at normal temperature. Clearly, when the nickel is passed through the furnace with the charge, this chilling effect is eliminated, and it is possible that for certain special castings a somewhat better result might be obtained by passing the nickel through the cupola, due to the slightly higher casting temperature. It might be mentioned in this connection that, when larger quantities of nickel cast iron are being made up, for convenience in handling the material, it is generally recommended that the nickel should be added in a suitable form with the charge in the furnace.

Referring to Mr. Howard's remarks concerning couplings, it is a matter of common experience that certain castings which have light sections requiring to be machined, may have also heavy sections which must at the same time be sound. Sometimes it is possible, by careful control of casting conditions, to meet all the requirements for such a casting, but in the use of nickel iron it is found that, through the latitude of the material, the desired effect may more easily be produced, and that, without any special casting precautions, and frequently without the use of denseners.

Finally, referring to the corrosion resistance of the higher nickel cast irons, it is known that certain alloy irons of the austenitic type possess good corrosion resistance; some of these irons, containing high nickel, with or without also copper and chromium, have been developed commercially. This subject, however, is receiving the active attention of many workers at the present time, and more information will probably shortly be available on this subject. As in the case of steels, some of the alloy cast irons are amenable to heat treatment in order to produce certain desired effects, as, for example, in the case of certain air hardening cast irons which have been referred to in the technical Press. (See Foundry Trade Journal, August 16, 1928, 39, 626, p. 112.)

Foundry Education.

At the invitation of the Board of Education, the Director of the Cast Iron Research Association delivered on July 27 a lecture on "The Educational Requirements of the Founding Industries" to the Summer School for Engineering Teachers at Merton College, Oxford. A number of distinguished leaders of industry were present during the period of the course.

General Refractories Staff Changes.

Mr. Oswald H. Wass, for many years the Lancashire and Yorkshire representative of the Company, has joined the head office (Sheffield) sales organisation as principal assistant. His previous duties are to be taken over by Mr. Stanley Brooks, of 398, Wellington Road North, Heaton Chapel, Stockport.

FTJ. 9-8-29.

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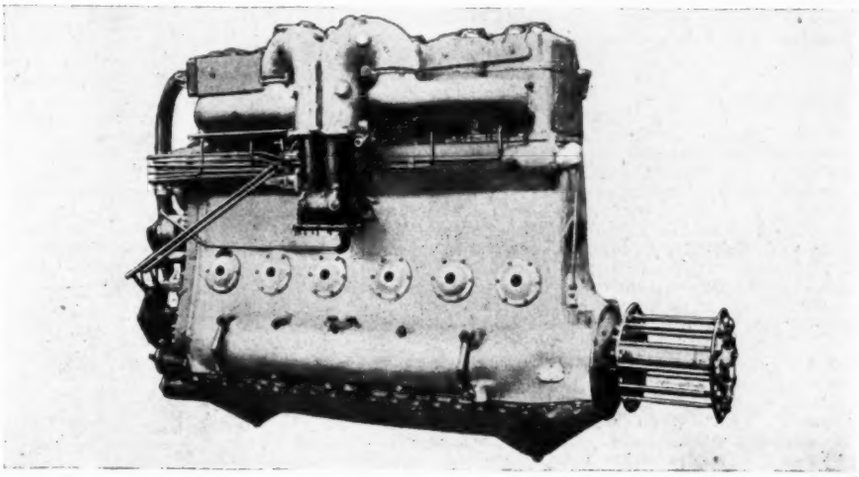

Here is one example — the BEARDMORE "CYCLONE" Aero Engine. The crankcase is of aluminium alloy and weighs 665 lbs.

For data on light alloys see the new B.A.C. Aircraft Booklet (gratis).

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Trade Talk.

Messrs. R. Y. Pickering & Company, Limited, Wishaw, have secured an order to build 150 covered steel goods vans for the L.M.S. Railway Company.

Messrs. Compressed Air, Limited, a recently formed company, are building and equipping Gressair Works, West Wharf Road, Cardiff, for the manufacture of their specialities.

Messrs. James Westoll & Company, Limited, of Sunderland, have placed an order for a collier of about 4,500 tons with Messrs. W. Pickersgill & Company, Limited, of Sunderland.

Messrs. Alfred Herbert, Limited, The Butts, Coventry, have purchased the complete plant and assets of the Clyno Engineering (Wolverhampton) Company (1922), Limited, of Pelham Street, Wolverhampton.

The Ailsa Shipbuilding Company, Limited, of Troon and Ayr, have obtained an order from British owners to build a cargo steamer of 600 tons deadweight. Machinery will be supplied by the builders at their Troon shops.

Recently cargoes of pig-iron shipped from the Prince of Wales' Dock, Workington, to foreign ports included 950 tons to Antwerp and 500 tons to Hamburg. During last week 1,350 tons of steel rails and 1,450 tons of pig-iron were consigned to home ports. A vessel left on July 30 with 2,000 tons of rails for South America.

Messrs. William Hamilton & Company (1928), Limited, Port Glasgow, have obtained from the Cia. Sud Americana de Vapores, Valparaiso, an order for two passenger and cargo steamers, each 250 ft. long, 51 ft. in breadth, 24 ft. in depth moulded to upper deck, of about 4,000 tons deadweight, and to have a speed of 12 knots loaded.

It was decided at a joint meeting of representatives of the National Union of Railwaymen and the Craft Unions, the Railway Shopmen's Joint Council, held in London on July 24, to give notice to the companies to terminate the present agreement, which provides for a reduction in wages of 2½ per cent., and expires in August.

Damage by fire was caused at the foundry of Messrs. Fletcher & Company, Litchurch Lane, Derby, on August 1. Mr. Matthews, the manager, discovered the fire. Fortunately, the damage was not serious, and the building is insured. The cause of the outbreak is unknown, but it is thought to have originated from a spark from the cupola.

Messrs. Pneulec, Limited, Mafeking Road, Smethwick, have been given exclusive selling and manufacturing rights in the British market for Bartlett-Snow special machinery for handling sand, moulds, cores and castings. Among these products are conveyors and elevators of many types, screens, magnetic separators, sand conditioners, pug mills, blenders, sand hoppers, gates, feeders, core crushers and cupola-charging units.

Mr. J. H. Thomas, Lord Privy Seal, at a luncheon at Olympia on Friday, July 26, speaking of a reference made by Mr. W. E. Hill, chairman of Olympia (Limited), who presided, to the spending of £600,000 on the enlargement of Olympia, said it was one of the few occasions on which he had known business men prepared to do something for industry without expecting a return from the Government. It is proposed to make Olympia the permanent home of the British Industries Fair.

The Board of Trade announces that, in a notice issued on July 25, it was stated by inadvertence that the Rt. Hon. A. V. Alexander had been appointed a member of the sub-committee of the Committee of Civil Research appointed by the Prime Minister to inquire into the iron and steel industries. The Secretary of State for War, the Rt. Hon. Thomas Shaw, C.B.E., M.P., should have been mentioned instead of Mr. Alexander as serving on this latter sub-committee.

In a notice to shareholders the directors of the United Steel Companies, Limited, and of United Strip and Bar Mills, Limited, announce that Austin Friars Trust, Limited, having paid the purchase price in respect of approximately 94 per cent. of the total securities and shares in these companies, it is now proposed to proceed with the necessary steps for the reconstruction of the capital of the companies, in accordance with the terms of the offer made by the Austin Friars Trust.

The decision of the Government to curtail work on naval armaments will, it is feared, result in considerable unemployment on Tyneside. The contract for machinery for the cruisers "Northumberland" and "Surrey" has not yet been placed, but it would probably have gone to the Tyne. The contracts for gun-mountings placed with Messrs. Vickers-Armstrongs, Limited, were to be carried out at Elswick and Barrow, and the cancellation of the contracts would lead to the discharge of more than 1,000 men.

The gas industry is to be honoured in October by a visit of the Duke and Duchess of York to the Conference of the British Commercial Gas Association at Eastbourne. This Association is a co-operative organisation of the gas industry of the British Empire for promoting commercial efficiency and for conducting publicity. It comprises 95 per cent. of the industry in this country, as measured by output, and is also supported by all the leading gas companies of the Empire. Undertakings as far apart as Sydney and Cape Town, Calcutta and Toronto are members of it.

The twin-screw motor cargo ship "Hindanger," the second of the three vessels which are being built for Messrs. Westfal-Larsen & Company, A/S Bergen, by Sir W. G. Armstrong, Whitworth & Company (Shipbuilders), Limited, was launched from their Walker shipyard on July 23. The "Hindanger" has an overall length of 415 ft., and is designed to carry 8,500 tons deadweight on a mean draft of 25 ft. 6 in. The main propelling machinery consists of two sets of single-acting Diesel engines of the enclosed trunk piston type, working on the four-stroke cycle, of the Burmeister & Wain-Harland & Wolff system, and developing 3,000 b.h.p. at 150 r.p.m.

There are new indications of growing industrial prosperity in the Motherwell district, where activity in the steelworks caused a curtailment of the holiday period to one of a week's duration. Orders on hand at the present time will keep the works going until the New Year. It is now announced that a big contract has been secured by Messrs. Hurst, Nelson & Company, Limited, to build 100 top-deck car bodies for the London County Council. The contract is valued at over £150,000, and it will keep the wagon works busy for a considerable time. The bridge-building firms in the district are also very busy on foreign contracts.

In a circular letter sent to the shareholders of the United Dominions Trust, Limited, the directors state that, in view of the developments in connection with the use of electric power throughout Great Britain, the board have for some time been actively considering special plans for extending the services of the company to cover the distribution under long-term credits (sale, hire or hire-purchase) of all kinds of electrical equipment for domestic or industrial purposes. The directors have decided that the best way to attain this object is by the formation of a separate and subsidiary company, and they give notice that a company is being registered with a capital of £250,000 for this purpose.

Mr. Duncan Bailey, chairman of Messrs. Charles Roberts & Company, Limited, railway wagon manufacturers, of Horbury Junction, near Wakefield, speaking at Leeds recently, said that the Government, in their efforts to find employment and at the same time to make the railway service efficient, would find a very fruitful field of development in wagon building. There were railway wagons in use at the present time which were over 30 years old, and these old wagons, which required constant attention, helped to create delays on the railways, and at times accidents. He had always recommended steel wagons, because they could produce the steel in this country instead of having to import large quantities of timber from abroad.

Birmingham Electric Furnaces, Limited, of 55, George Street, Parade, Birmingham, have received an order from Messrs. David Brown & Sons (Huddersfield), Limited, Park Works, Lockwood, Huddersfield, for a furnace having a usable hearth 14 ft. long by 3 ft. 3 in. wide, with a maximum rating of approximately 200 kw. This furnace is double-ended, and will be used for re-heating and carburising. It is thought that this will be the largest electric furnace for this purpose in the country. In addition Messrs. David Brown & Sons have already four electric furnaces in operation for heat-treatment purposes, three of which are supplied by this concern. In addition to the above, an order has been received from Messrs. Chas. Clifford & Son, Limited, Fazeley Street Mills, Birmingham, for an electric furnace having a usable hearth 7 ft. long by 3 ft. 9 in. wide, with a maximum rating of approximately 120 kw., for brass annealing. This furnace will be supplied complete with "Birlec" 3-arm electrically-driven charging machine and loading trolleys.

Personal.

Dr. Lewis F. Richardson, who has been for some time head of the Physics Department of the Westminster Training College, has been appointed Principal of Paisley Technical College, in succession to Mr. Angus Maclean, who has retired.

Mr. H. C. Bond, of Messrs. Richard Thomas & Company, Limited, has been elected chairman of the Welsh Plate and Sheet Manufacturers' Association, in succession to Mr. W. B. Hallowes, of Messrs. R. B. Byass & Company, Limited, who has resigned after two years' service, on account of ill-health.

Mr. J. E. Jadoul, of Binders International Company, owing to health, etc., considerations, has left Manchester, and is at present staying at 21, rue de Paris, Le Touquet-Paris Plage, France. It is Mr. Jadoul's intention to represent British foundry supply and equipment firms in France, Spain and Italy.

Mr. E. B. Sanigar, Jun., investigator in electrometallurgy at the University of Sheffield, has been awarded the Edward Weston Fellowship in electrochemistry by the American Electro-Chemical Society. He is the first holder of the award and has been elected to attend the Columbia University. Mr. Sanigar has been engaged on research work in silver-plating.

Mr. F. Thomas Jenkins, who is well-known in the foundry industry owing to the official position he held for some years in the plant and machinery section of the Disposals Board, has become a partner in the Industrial and Chemical Engineering Company, Limited, Stephen's House, Westminster, London, S.W.1, the senior partner of which firm is Mr. H. Kingsley Foster.

Mr. Ronald W. Matthews, of Sheffield, has been appointed a director of the L. & N.E. Railway Company. Mr. Matthews, who is chairman of the Sheffield Chamber of Commerce, is vice-chairman and managing director of Messrs. Turton Bros. and Matthews, Limited, steel, file and spring manufacturers, chairman and managing director of Messrs. J. P. Skinner & Company, Limited, light spring manufacturers, and a director of Messrs. Marshall, Sons & Company, Limited, engineers, of Gainsborough.

Dr. D. S. Anderson, B.Sc., Ph.D., Associate of the Royal Technical College, Glasgow, has been appointed principal of the Birmingham Central Technical College, in succession to Dr. W. E. Sumpner, who retired recently. Dr. Anderson has been principal of the Derby Technical College since September, 1928, and previous to that date he was for two years head of the engineering department of the Derby Technical College. In 1922 Dr. Anderson held a full-time appointment in the mechanical engineering department of the Royal Technical College, Glasgow, where he was in charge of the post-graduate students. He also spent four years in the works of the North British Locomotive Company, Limited, at Glasgow.

Wills.

Stothert, Sir P. K., K.B.E., D.L., J.P., of West Bath, chairman of Messrs. Stothert & Pitt, crane makers, of Bath	£99,727
Turner, George, of Birmingham, chairman of the Midland Railway Carriage and Wagon Company, managing director of Wrights Ropes, and a director of Cammell Laird & Company	£229,881

Contracts Open.

New Zealand, August 19.—Cast-iron water pipes, for the Gisborne Municipal Council. The Department of Overseas Trade. (Reference A.X. 8,312.)

Padiham, August 14.—4,750 yds. of 3-in. cast-iron water mains, for the Urban District Council. Mr. H. Russell, Council Offices, Padiham.

Billinge, August 12.—Oil-engine and pump, for the Billinge and Winstanley Urban District Council. The Surveyor, the Council Offices, Billinge, near Wigan.

Obituary.

Mr. James K. Catto, a partner in the firm of Messrs. Catto, Mather & Company, Limited, iron and steel merchants, of Liverpool, died suddenly on July 18. For twenty-five years Mr. Catto was a justice of the peace for Wirrall.

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We don't ask for orders for 500-ton lots (payment against B/L), we sell in truck loads and wait for our money—sometimes three or four months (sometimes we never get it at all). We are always here at the end of a wire for advice, help or support. If you receive from us any goods you don't like—send them back.

We give prompt delivery of Yorkshire Sand and every ton lot of it you buy finds work for Englishmen and Scotsmen and helps to improve your own business by circulating more money in the country, and reducing the amount sent abroad for needless foreign purchases.—Think it over and you will see we are right.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Production of pig-iron in the Cleveland area, though progressively increasing, has for some time past been far from adequate to meet current demands, and with stocks practically non-existent, the position becomes more and more difficult as the season advances. Additional furnaces already in operation, with further extensions of output in prospect at an early date, bringing the total to 47 in operation in the district, will, however, ease the situation to some extent, providing sufficient supplies of raw material are available, but meanwhile most of the iron produced is consumed locally, and deliveries both to Scotland and also to foreign ports are declining. Cleveland pig-iron prices are too high to offer much hope of foreign trade, but no immediate change of values is likely. Prices are justified by the high cost of materials, and if consumers are disinclined to follow an advance, works costs make any concessions improbable. Thus, for forward deliveries, prices are steady, as follow:—No. 1 Cleveland foundry iron, 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge, 71s. per ton.

In contrast with foundry pig, there is no scarcity of hematite iron, the production of which has kept pace with the demand. Though it is claimed that an economic figure for East Coast hematite would not be below 80s., makers ask no more than 75s. 6d. for mixed numbers, with No. 1 grade at a premium of sixpence. On the North-West Coast, Bessemer mixed numbers are still quoted at 75s. per ton at works.

LANCASHIRE.—The position in the local markets for foundry pig is practically unchanged, with prices firm at previous quotations, as follow:—Staffordshire No. 3, 75s. 6d., Derbyshire No. 3, 74s. 6d.; with Scottish brands at 91s. to 93s. 6d., all per ton delivered local stations.

THE MIDLANDS.—Markets in this area report little business moving, due to holiday influences, most of the consuming works being temporarily out of action. The zone prices are being quoted, and no premiums are being exacted. The controlled prices are 72s. 6d. for Northants No. 3, 76s. for Derbyshire No. 3, and 77s. for North Staffordshire, delivered to local stations.

SCOTLAND.—Practically all the works have resumed after the annual holidays, but in most cases business is rather quiet. There is a fair demand for steel-making iron, but for foundry iron the demand is, generally speaking, poor. There is no change in the minimum price for No. 3 Scotch foundry iron, which remains at 76s. f.o.t. furnaces.

Finished Iron.

There have been no fresh developments in the Birmingham market during the last week or so. Business in crown iron is dwindling again after a somewhat better period, and there is much competition amongst the makers in this and other areas for orders emanating from this district. The price for this class of iron continues to vary considerably. In Staffordshire it is between £10 and £10 5s. per ton, but crown can be obtained in certain districts at as low as £9 12s. 6d. to £9 15s. per ton delivered. The price for Staffordshire marked bars remains at £12 at works, and the mills making this grade of bar continue to be fairly well engaged, and business is coming through at a moderately good rate.

Steel.

At Sheffield this week only a moderate volume of transactions has been reported in the steel market, the feature being the demand for basic billets, prices of which are very firmly held. The Lincolnshire producers are stated to have agreed to form an association which controls the prices of high-carbon basic billets, and, if this is so, then practically the whole of the makers will be embraced. Acid billets are in only small request. Another rise has occurred in the prices of tungsten, and high-speed steel makers are rather alarmed. Current quotations are:—Siemens acid billets, £9 10s.; basic billets, soft, £7; semi-hard, £7 12s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; steel hoops, £9 10s. to £9 15s. The tinplate market continues steady, quotations ranging as follow:—Coke quality, 18s. 1½d. to 18s. 3d. basis, net cash, f.o.b. Wales.

Scrap.

With deliveries virtually suspended over the current week, markets for scrap material have very little actual business to report. At Middlesbrough prices remain fairly steady, heavy cast iron being quoted at 66s., with good machinery quality at 68s. 6d. per ton, delivered works. In the Midlands cast-iron scrap is firm, 70s. to 72s. 6d. being quoted for machinery scrap in cupola sizes, and 60s. for light cast-iron scrap. In Scotland the market for cast-iron scrap is quiet, and it is difficult to find outlets even for first-class machinery at around 70s. per ton, while for heavy ordinary cast iron 64s. to 65s. per ton is asked. Old cast-iron railway chairs are quoted at 66s. per ton, with few buyers, and light cast iron at 60s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—The steady advance in warrant copper quotations noted in previous reports continues unchecked so far, although the actual daily turnover indicates the customary decreased average as compared with normal periods. Buying, moreover, does not develop along the lines anticipated, and producers still insist that European consumers are short of metal and will be forced to enter the market once again in the near future. Obviously, there is a certain amount of truth in this statement, and there is no doubt that before long there must be a quickening of the demand.

Closing quotations are :—

Cash.—Thursday, £73 5s. to £73 7s. 6d.; Friday, £73 5s. to £73 7s. 6d.; Tuesday, £73 11s. 3d. to £73 13s. 9d.; Wednesday, £73 15s. to £73 17s. 6d.

Three Months.—Thursday, £73 16s. 3d. to £73 17s. 6d.; Friday, £73 18s. 9d. to £74; Tuesday, £74 7s. 6d. to £74 10s.; Wednesday, £74 12s. 6d. to £74 15s.

Tin.—Markets for standard cash tin during the past week presented a more satisfactory appearance, while buying, both in this country and on the Continent, has been steady and confident. An analysis of the tin statistics for July shows a fall in the visible supply at 23,772 tons. The decrease is of 164 tons only, but it is the sixth reduction recorded this year—thus showing that demand keeps ahead of current supply. The present visible supply is virtually the same as at December 31 last. American consumption in the seven months was 54,955 tons, an increase of 10,950 tons.

Official closing prices :—

Cash.—Thursday, £212 17s. 6d. to £213; Friday, £213 5s. to £213 7s. 6d.; Tuesday, £212 17s. 6d. to £213; Wednesday, £212 2s. 6d. to £212 7s. 6d.

Three Months.—Thursday, £217 to £217 2s. 6d.; Friday, £217 2s. 6d. to £217 5s.; Tuesday, £216 17s. 6d. to £217 2s. 6d.; Wednesday, £216 5s. to £216 7s. 6d.

Spelter.—Consumptive demand, both in this country and on the Continent, is very dull, and there is little prospect of any revival of interest in the immediate future. There are, however, no reasons for regarding the present quietude as anything but a temporary state of affairs, and, when the curtailment of production takes effect, the trade demand should once again assume more normal proportions.

Daily quotations are :—

Ordinary. — Thursday, £25 1s. 3d.; Friday, £25 1s. 3d.; Tuesday, £25 1s. 3d.; Wednesday, £25 1s. 3d.

Lead.—The market for soft foreign pig continues very quiet, and, with no buying from the Continent, prices have sunk to a somewhat low level, but should rise again with any favourable development.

Prices have been :—

Soft Foreign Prompt.—Thursday, £23 3s. 9d.; Friday, £23 6s. 3d.; Tuesday, £23 8s. 9d.; Wednesday, £23 7s. 6d.

Students' Corner.

Q.—How is the blast heated ?

A.—There are various kinds of stoves for heating the blast. One of the oldest type is the U-pipe stove. This type of stove is a series of flat U-shaped pipes 12 in. by 14 in. inside area and 12 ft. long. They stand vertically in the stove, the spigot ends fitting into sockets of the main ; the stove is rectangular in shape, with an inlet at the bottom for the waste gases from the blast furnace and apertures in the walls for air. The cold-blast from the blowing engine passing through the U-pipes in the heated stove becomes quite hot by the time it is delivered to the furnace.

There are two regenerative types of heating stoves—" Cowper " and " Whitwell."

The shell of a Cowper stove is of wrought iron or steel ; it stands 60 ft. high and is 25 ft. dia. The working of the stove is as follows :—The interior of the stove with the exception of the space taken for the combustion chamber and top of the dome is all chequer brickwork, which absorbs the heat until red-hot. The so-called waste gases enter by one inlet valve and the air at another. These, in controlled proportions, enter the combustion chamber, where ignition takes place. The burning gases ascend the flue, pass over the bridge and downwards, heating the chequered brickwork, and escape through a chimney valve to the stack.

Q.—What time is required for heating the stove sufficiently ?

A.—From two to three hours. When this has been done the various valves are closed and the hot-blast valve is opened. The cold air enters near the bottom and ascends through the heated brickwork to the top and downwards by way of combustion chamber, and then escapes by a valve which communicates with the blast furnace.

Q.—What temperature is the blast when it enters the blast furnace ?

A.—About 800 deg. C. When the blast falls to 600 deg. C. the stove is once more reheated.

Q.—How many stoves are necessary to supply hot blast continuously for each blast furnace ?

A.—For regular working three stoves are generally in use for one furnace.

Q.—What is now the capacity of an average blast furnace ?

A.—About 30,000 cub. ft. The stock in the furnace when charged would weigh about 700 tons.

Q.—What are the general dimensions of a modern blast furnace, i.e., the height and internal measurements ?

A.—About 90 to 100 ft. in height and 20 to 25 ft. dia.

Q.—What length of time is required to reduce the ore to iron ?

A.—The time taken to reduce the ore will depend upon the working of the furnace, blast pressure, etc., but 46 to 50 hours is occupied from the time the charge is put into the furnace until it is tapped out on to the pig bed.

Q.—What is the blast-pressure necessary for the blast furnace ?

A.—This varies according to type of furnace, but, generally speaking, the blast pressure varies between 7 and 14 lbs.

Q.—What is the product of the blast furnace ?

A.—Various grades of pig-iron, slag (and slag wool), gases, etc.

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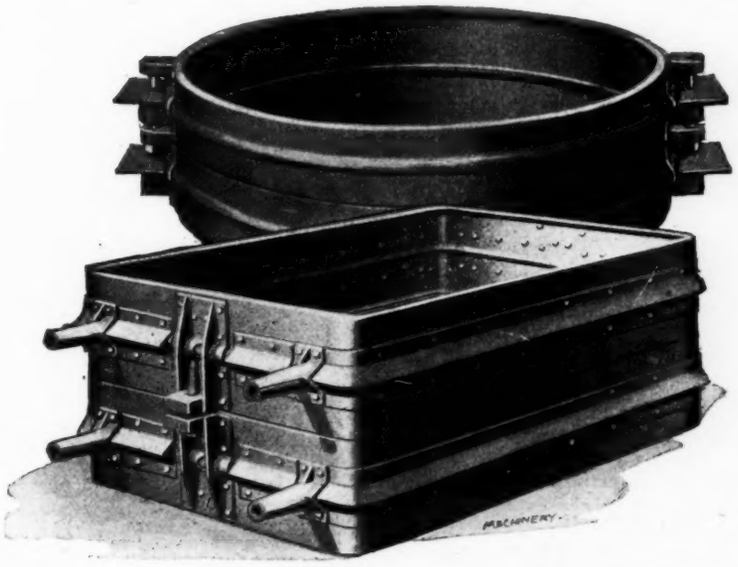

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Off. av. cash, July	72 3 11 13/16
Do. 3 mths., July	72 15 3 5/16
Do., Sttlmnt., July	72 3 8 5/16
Do., Electro, July	84 5 9 5/16
Do., B.S., July	75 11 4 5/16
Aver. spot price, copper, July	72 3 11 13/16
Do. wire bars, July	84 10 9 5/16
Solid drawn tubes	15d.
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BRASS.

Solid drawn tubes	12½d.
Brazed tubes	14½d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	10½d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8½d.
Do. 4 × 3 Sheets	9d.

TIN.

	£ s. d.
Standard cash	212 2 6
Three months	216 5 0
English	212 15 0
Bars	215 10 0
Straits	216 7 6
Australian	215 2 6
Eastern	220 5 0
Banca	Nominal
Off. av. cash, July	209 11 6 5/13
Do., 3 mths., July	213 0 1 5/13
Do., Sttlmt., July	209 11 6 5/13
Aver. spot, July	209 11 6 5/13

SPELTER.

	£ s. d.
Ordinary	25 1 3
Remelted	22 15 0
Hard	21 0 0
Electro 99.9	27 0 0
English	25 7 6
India	22 0 0
Zinc dust	(Nom.) 34 10 0
Zinc ashes	8 15 0
Off. aver., July	25 7 6 1/26
Aver., spot, July	25 6 7 13/26

LEAD.

	£ s. d.
Soft foreign ppt.	22 7 6
English	24 15 0
Off. average, July	22 16 10 11/26
Average spot, July	22 16 2 5/13

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	34 10 0
Do. V.M. ex-whf.	32 12 6
Rods	40 0 0
Boiler plates	30 10 0
Battery plates	31 0 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	50 5 0
Chinese	31 10 0
Crude	Nominal

QUICKSILVER.

	£ s. d.
Quicksilver	22 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	7 15 0
45/50%	12 0 0
75%	19 10 0
Ferro-vanadium—	
35/50%	12/10 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/- lb. Mo.
Ferro-titanium—	
23/25% carbonless	11d. lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%, c. fr.	3/3½ lb.
Tungsten metal powder—	
98/99%	3/6½ lb.
Ferro-chrome—	
2/4% car.	£32 10 0
4/6% car.	£23 15 0
6/8% car.	£23 0 0
8/10% car.	£22 15 0
Ferro-chrome—	
Max. 2% car.	£33 15 0
Max. 1% car.	£37 12 6
Max. 0·70% car.	£41 12 6
70%, carbonless	1/2 lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/4 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/6 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80%, export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

South Wales—	£ s. d.	£ s. d.
Heavy steel		3 17 6
Bundled steel and shrngs.	3 12 6	to 3 15 6
Mixed iron and steel	3 10 0	to 3 12 6
Heavy cast iron		3 2 6
Good machinery for foundries		3 7 6
Cleveland—		
Heavy steel		3 5 0
Steel turnings		2 17 6
Cast iron borings		2 17 6
Heavy forge		3 17 6
W.I. piling scrap		3 12 6
Cast-iron scrap	3 6 0	to 3 8 6
Lancashire—		
Cast-iron scrap	3 0 0	to 3 10 0
Hvy. wrought		3 12 6
Steel turnings		2 17 6
Scotland—		
Heavy steel		3 16 0
Cast-iron borings		2 14 6
Wrought-iron piling		3 13 6
Heavy machinery		3 10 0

London—Merchants' buying prices delivered yard.

Copper (clean)	62 0 0
Brass	41 0 0
Lead (less usual draft)	20 0 0
Tea lead	16 10 0
Zinc	17 0 0
New aluminium cuttings	68 0 0
Braziery copper	54 0 0
Gunmetal	54 0 0
Hollow pewter	150 0 0
Shaped black pewter	106 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	76/-
Hematite M/Nos.	75/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	92/-
Midlands—	
Staffs. common*	—
,, No. 4 forge*	73/6
,, No. 3 fdry*	77/-
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	68/-
,, fdry. No. 3*	72/6
Derbyshire forge*	72/6
,, fdry. No. 3*	76/-
,, basic*	—

* d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
,, No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	67/-
,, fdry. No. 3	71/-
Lincs. forge	—
,, fdry. No. 3	72/6
E.C. hematite	86/6
W.C. hematite	87/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	74/6
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	93/6
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/6
Monkland, No. 3	93/6
Shotts, No. 3	93/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.		10 15 0
Nut and bolt iron	9 0 0	to 9 5 0
Hoops	11 0 0	to 11 10 0
Marked bars (Staffs) f.o.t.		12 0 0
Gas strip	11 0 0	to 11 10 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 12 6	to 8 17 6
Boiler plts.		10 10 0
Chequer plts.		10 12 6
Angles		8 2 6
Tees		9 2 6
Joists		8 2 6
Rounds and squares, 3 in. to 5½ in.		9 2 6
Rounds under 3 in. to ⅜ in. (Untested)		8 0 0

and upwards

Flats, over 5 in. wide and up	8 7 6
Flats, 5 in. to 1½ in.	7 17 6
Rails, heavy	8 10 0
Fishplates	12 10 0
Hoops (Staffs)	10 0 0 to 10 10 0
Black sheets, 24g.	10 5 0 to 10 10 0
Galv.cor.shts., 24g.	13 5 0 to 13 10 6
Galv. fencing wire 8g. plain	12 0 0
Billets, soft	6 7 6 to 6 15 0
Billets, hard	7 10 0 to 8 2 6
Sheet bars	6 5 0 to 6 10 0
Tin bars	6 5 0 to 6 10 0

PHOSPHOR BRONZE.

Per lb. basis.

Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

per lb.

Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/- to 30/-
,, furnace	22/- to 24/-
Durham and North.	
,, foundry	18/6 to 20/6
,, furnace	19/-
Midlands, foundry	—
,, furnace	19/- and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/3
,,	28×20 ,,	36/6
,,	20×10 ,,	26/3
,,	18¾×14 ,,	18/9
C.W.	20×14 ,,	15/3
,,	28×20 ,,	33/6
,,	20×10 ,,	21/3
,,	18¾×14 ,,	16/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0	to £7 10 0
Bars, hammered, basis	£17 10 0	to £18 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 15 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£32 0 0	to £33 0 0
Faggot steel	£20 0 0	to £24 0 0
Bars and rods, dead soft, steel	£10 0 0	to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

Electrolytic Copper.

		£ s. d.		
Aug.	1	84 5 0	No change	
„	2	84 5 0	„	„
„	6	84 5 0	„	„
„	7	84 5 0	„	„

Tin (English ingots).

		£ s. d.		
Aug.	1	213 5 0	dec.	15/-
„	2	213 10 0	inc.	5/-
„	6	213 10 0	No change	
„	7	212 15 0	dec.	15/-

Spelter (ordinary).

		£ s. d.		
Aug.	1	25 1 3	dec.	1/3
„	2	25 1 3	No change	
„	6	25 1 3	„	„
„	7	25 1 3	„	„

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.		
Aug.	1	73 5 0	inc.	1/3
„	2	73 5 0	No change	
„	6	73 11 3	inc.	6/3
„	7	73 15 0	„	3/9

Standard Tin (cash).

		£ s. d.		
Aug.	1	212 17 6	dec.	12/6
„	2	213 5 0	inc.	7/6
„	6	212 17 6	dec.	7/6
„	7	212 2 6	„	15/-

Zinc Sheets (English).

		£ s. d.		
Aug.	1	34 10 0	No change	
„	2	34 10 0	„	„
„	6	34 10 0	„	„
„	7	34 10 0	„	„

Lead (English).

		£ s. d.		
Aug.	1	24 10 0	inc.	5/-
„	2	24 15 0	„	5/-
„	6	24 15 0	No change	
„	7	24 15 0	„	„

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	2 3 0	2 3 0	2 2 6	2 2 6	2 2 6	2 4 0	2 3 6	2 4 0	2 5 0	2 5 6	2 6 6	2 5 6	2 3 11½
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 6	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12 6	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	—	—	—	—	—	—

* No prices available during strike period.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG

IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

FOUNDRY MANAGER, with thorough practical and technical training, desires position where experience of all-round foundry work is required. Good references from well-known firms.—Box 290, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT MANAGER (30), Irish Free State foundry, seeks position as Representative for progressive firm doing business in Ireland; ten years' sound commercial and practical experience, all departments; efficient salesman, capable of introducing business; highest references.—Box 282, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN, with thorough practical and technical training, desires position where experience and ability is required; up to date on all classes of iron and non-ferrous work, mix all metals by analysis; McLain and I.C.S. graduate; take entire charge of foundry and pattern shop.—Box 268, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER (ferrous and non-ferrous) desires new appointment; good all-round general experience; special knowledge of automobile work; would consider position (salaried) with foundry suppliers of repute.—Box 276, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—FOREMAN for steel foundry in North of England having output of 50 to 60 tons castings weekly; must have thorough knowledge modern steel foundry methods and hold similar position in first-class works; preference given to man with experience of open-hearth, converter, and electric furnaces; state age, qualifications, fully, and salary required.—Box 288, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES.

PIG-IRON. — ENGINEER, with intensive foundry and sales experience, etc., is open to travel Midland counties for important blast-furnace company.—Address, Box 280, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES—*Continued.*

WANTED, First-class District Agents to sell all classes of Foundry Plant and Equipment in the following areas:—

Manchester, Sheffield,
Leeds, Newcastle-on-Tyne,
Middlesbrough, Birmingham,
Leicester.

Generous commission paid.

Apply, Box 274, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—King's Patent Agency, Limited, 146a, Queen Victoria Street, E.C.4.

PROPERTY.

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.

SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MACHINERY.

80 cub. ft. Tilghman AIR COMPRESSOR for 100 lbs. pressure, arranged for motor drive, without motor.

130 cub. ft. Tilghman AIR COMPRESSOR for 100 lbs. pressure, arranged for motor drive, without motor.

7 in. x 10 in. Tangye HORIZONTAL ENGINE, Colonial type.

Portable PUMPING SETS, comprising 2½-h.p. Oil Engine, with Diaphragm Pump, approx. capacity 6,000 galls. per hr., on 4 road-wheels.

15-ton LOCO. STEAM CRANE (Cowan, Sheldon), 31-ft. 9-in. jib; 10-ft. gauge, 100 lbs. w.p.

7-ton LOCO. ELECTRIC GRABBING CRANE (Smith), 40-ft. jib; 7-ft. gauge; but convertible to 4 ft. 8½ in.

Eight LANCASHIRE BOILERS, 30 ft. 0 in. x 8 ft. 0 in., re-insure 150 lbs. pressure.

100,000 ft. of 4-in. Wrought Iron Screwed and Socketed Pipes, about 18 ft. 6 in. lengths.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

FOR SALE.—One 2-ton Cupola by Ketin & Thiriart, complete with lift for loading platform.—Full particulars, Box 286, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

1½-TON HEROULT ELECTRIC STEEL FURNACE for Sale.—Box 270, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS.

NORTHAMPTON GANISTER. Send your inquiry to others first then come to me. My Price Smashes the Lot.—Stafford, Lowick, Northants.

FOUNDRY REQUISITES

Try our REFRACTORIES.

Ganister or Silica Bricks and Blocks (any shape or size) **Sands, Cements, Ganister.**—*Let us have your enquiries*

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